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THE ANNEALING OF FLAT GLASS

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Abstract

The effect of temperature upon structural state of a given glass was established by studying the effect upon equilibrium density. In addition, the influence on residual birefringence of thickness, cooling rate and stabilization-relaxation conditions was investigated.

Rapid quenching from a higher "equilibration" temperature to the stabilization-relaxation temperature resulted in greater residual birefringence than if the cooling rate was lower. (Equilibration" temperature, T_s, is that initial temperature that is high enough to cause rapid erasure of thermal history.) The residual birefringence at room temperature decreased as the structural state at the beginning of the cooling schedule approached that of $T_i = \theta_{tr}$-50°C. (θ_{tr} = dilatometric transformation temperature.)

These two observations and the fact the time vs temperature curve for the natural cooling rate is similar to the stabilizing time vs temperature curve suggested that natural cooling could be used between T_s and T_i. Experimental results appeared to confirm the view.

PART II †

I. Defining a Glass in Terms of Its Structural State (Density)

This method of characterization consists (knowing the structural state of well annealed glass and the structural state of tempered glass) in expressing the average structural state of the glass being tested as per cent of the maximum of stabilization possible. For example:

	density		
Perfectly annealed glass ...	2.5278		
Test sample	2.5203	0.0051	0.0126
Quenched glass	2.5152		

$$\% \text{ stabilization } \frac{0.0051}{0.0126} \times 100 = 40.5\%$$

In principle, this way of characterizing a glass would require the complete equilibrium density curve, such as shown in Fig. 4. Obtaining this complete curve is a relatively long process which many manufacturers would hesitate to undertake, but if practical requirements are considered, an approximation may be made without incurring too great a loss of precision. It is sufficient to determine the lower part of the curve as far as the beginning of the ascending part, and to join the last point of this section to the point representing a practical equilibrium value for a temperature located 50° below the dilatometric transformation point.

This last density is determined after a stabilization for five or six days, and air quenching. For most glasses, the density found after this treatment is very close to the equilibrium density at θ_{tr}–50°C. and is sufficiently accurate for a first approximation.

The density beyond the transformation range is obtained by "stereotyping". The experimental method employed for this "stereotyping" is important, for the cooling rate and the dimensions of the sample have an influence on the degree of quenching.

In order to limit the variables, all the samples were milled to 3 mm. diam. cylinders. Samples 2.4 and 4.6 mm. long showed that the influence of this third dimension was not perceptible: for the 2.4 mm. glass, the average density of seven samples was 2.4990, equal to that found for twelve 4.6 mm. samples.

"Stereotyping" was carried out in the following manner: The samples were kept for five minutes at θ_{tr}+150°C., and then were dropped into a bath of molten salt 400°C. below the preceding temperature, where they remained one minute. It is important that these two soaking times be always the same, for a longer or shorter stay in the bath can cause considerable variation in the initial temper.

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† Part II of a two-part article. Part I, translated by F. W. Preston, appeared in the February 1952 issue of THE GLASS INDUSTRY.

The temperature from which the quenching originates was selected not only to be well above the transformation region, but also one where the glass did not adhere to its porcelain support. Preliminary experiments showed that quenching from a temperature between $\theta_{tr}+100°C.$ and $\theta_{tr}+150°C.$ produced practically the same final density.

To complete the approximate curve, it was necessary to determine the position of the lower bend of the equilibrium density curve. For this purpose the departure temperature was gradually lowered. The density after quenching was measured until the density-temperature curve showed a clear inflection upward towards greater densities. For purposes of comparison, similar measurements were made using air-cooling to obtain a milder quench. In examining the following table:

	Liquid Soaking Densities			Average	Diff. x 10^4	Air Cooling	Air Cooling brought to Av. 2.5059	Diff. x 10^4
730°	2.5059	2.5059	2.5059	2.5059				
650°	2.5059	2.5059	2.5058	2.5059		2.5095	2.5059	
					3			3
630°	2.5064	2.5063	2.5059	2.5062		2.5098	2.5062	
					9			10
620°	2.5072	2.5072	2.5069	2.5071		2.5108	2.5072	
					10			11
610°	2.5081	2.5081	2.5080	2.5081		2.5119	2.5083	

we note that air cooling, while producing a weaker temper, does not influence the position of the beginning of inflection on the temperature axis or the amount of density variation; i.e., it is possible to utilize air cooling to determine the position of the bend on the temperature axis.

To sum up, knowledge of the density after a stabilization of five or six days at $\theta_{tr}-50°C.$, the density of glass cooled from $\theta_{tr}+150°C.$, and the position of the lower bend of the curve of equilibrium densities makes it possible at the first approximation to draw the curve of equilibrium densities. Once this curve is drawn, the position of the point representing the density of the glass being tested makes it possible to infer its average structural state, and to characterize the annealing as per cent of structural stabilization.

It is evident that comparison of the percentages of structural stabilization between two different glasses has no absolute significance, for there always is an uncertainty as to all the structural transformations acting on the density during the "tempering" cycle. It is possible, however, to watch the annealing of a glass (or to follow the variation of the annealing) during modifications applied to the annealing cycle in the factory.

Another objection may be raised due to the fact that the ordinary glass (apart from optical glass) may contain a heterogeneity of composition which, a priori, influences the density. What significance can be attached to the numerical value of the density under such circumstances?

For the answer to this question, we examined five industrial flat glasses obtained by the current manufacturing methods, e.g.: Fourcault glass, Pittsburgh glass, continuous cast ornamental glass, continuous cast glass and glass molded by Bicheroux machine.

Three different samples of Fourcault glass were used: glass from the A and B machines the same day and glass from the A machine, 24 hours later.

The glasses were:

10 161 I Fourcault machine B glass, 2.4 mm. thick;
10 162 I Fourcault machine A glass, 4.6 mm. thick;
10 162 II Fourcault machine A glass, 24 hours later;
10 198 Pittsburgh glass, 4.9 mm. thick, 212 cm wide;
10 188 Ornamental glass, continuous casting, 6.7 mm. thick;
10 173 glass A, continuous casting, 6.9 mm. thick, 252 cm wide;
10 190 glass A, Bicheroux machine, 7.5 mm. thick, 411 cm wide.

On the first six glasses, we took at regular intervals on the width of the sheet three cylindrical samples following one another at one centimeter intervals in the direction of drawing or rolling so as to obtain 12 groups of 3 mm. samples. On the seventh sheet, we took 19 groups of 3 mm. samples.

Each lot of "crude" cylindrical test samples was subjected to "prestonizing"*, and each test sample of a group of three was marked. After "prestonizing" the crude glass, one test sample from each group of three was quenched from $\theta_{tr}+150$ while another was stabilized at $\theta_{tr}-50°C.$ for five or six days. After quenching in the one case and after stabilization in the other, the density was again determined by prestonizing. In this way, we obtained not only the average density of the "crude" glass, but likewise the dispersion of the value of the "crude" densities. The dispersion was due to the chemical heterogeneity and, eventually, to the heterogeneity

* Determination of density by means of the Preston apparatus.

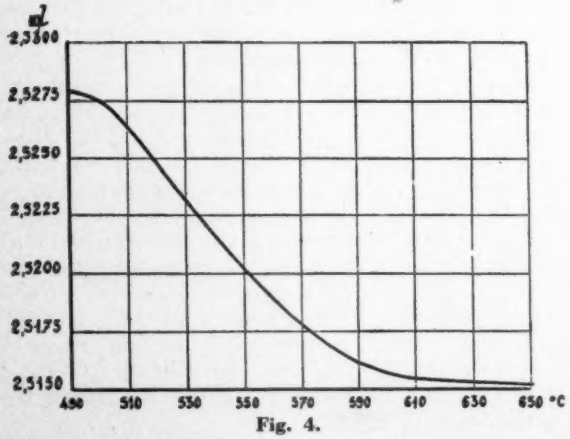
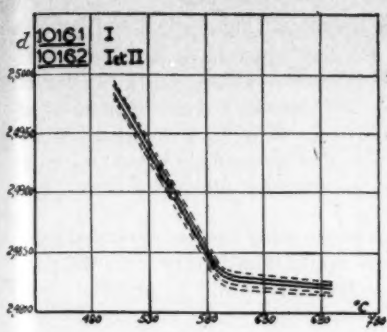


Fig. 4.



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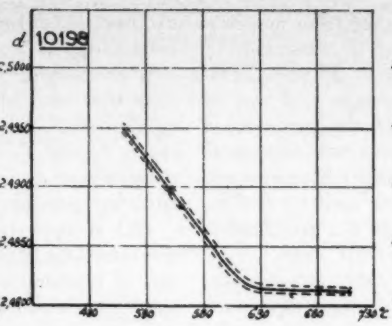

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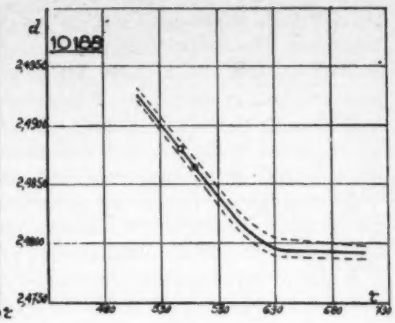


Fig. 7.

of the annealing. Likewise, we obtained the average value and the dispersion of the tempered glass and of the stabilized glass.

Part of the samples which had served to determine the "tempered" density were next used to determine the lower bend of the approximate equilibrium density curve.

Figures 5, 6, 7, 8 and 9 present the data for the various glass. The numerical values used in plotting these curves are given in extenso in the table in the appendix.

On the approximate curves of equilibrium, the value of the density of the crude glass (open circles) is plotted. Also plotted (solid circles), in order to verify their significance, are the equilibrium densities corresponding to an intermediate point between the high and the low density for each glass. The intermediate density selected is that corresponding to the dilatometric transformation point, θ_{tr}.

It appears from examination of these curves that the equilibrium density at the dilatometric transformation point, determined on any sample of the glass to be examined, is located well inside the region of dispersion of the densities. On the other hand, examination of the group of the curves related to the glasses 10 161 I and 10 162 I makes it possible to reestablish the exact order in which these two glasses must be as a function of their thermal history. Glass 10 161 I, being thinner, was rolled at a speed higher than that with which glass 10 162 I was rolled. In other words, glass 10 161 I traversed the transformation region more rapidly than glass 10 162 I, and its structural stabilization was less advanced than that of glass 10 162 I. The position of the points of "crude" glass on the approximate curve of equilibrium density confirms this.

On the other hand, comparison of the averages of the birefringence measured at the places where the samples were taken for density determinations indicates that glass 10 162 I is more tempered (63.5 μ/cm) than glass 10 161 I (41.5 μ/cm), although it is more stabilized.

Establishing this last fact led us to examine the influence of the stabilization, i.e., of the structural effect, on the birefringence induced during cooling and, in general, of examining the birefringence in the light of the structural concept.

II. Influence of Stabilization Upon the Birefringence Induced During Cooling

In the first part of this paper there was published: the curve of equilibrium density as a function of temperature, the curves of rate of establishment of equilibrium for various temperatures as functions of time, and relaxation curves at various temperatures. In this second part we propose to study birefringence induced during cooling as a function of (a) Thickness of the sample, (b) Time of stabilization, (c) Temperature of stabilization and (d) Rate of cooling.

So as not to complicate the experimental series, the study of thickness is limited to samples 31 x 54 x 2.5 mm., 31 x 54 x 5.0 mm. and 31 x 54 x 10 mm. Also limited are: temperature of stabilization to 530°C., 510°C.; rate of cooling to 5°/min, 18°/min; and cooling in open air and time of stabilization to 30, 35, 300 min. at 530°C. and 20, 50, 300, 900 min. at 510°C.

The experimental procedure was as follows: Each experiment, comprising a heat treatment and a cooling process, was done simultaneously for the three thicknesses. The samples were placed on a support permitting 1 cm spacing. The support was in contact with the glass only at few points. This assembly was introduced into a

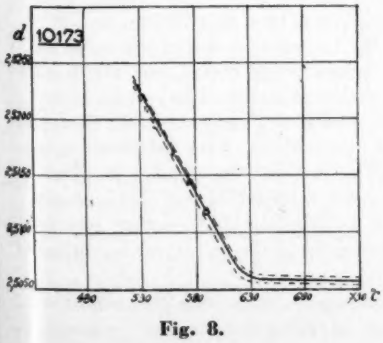


Fig. 8.

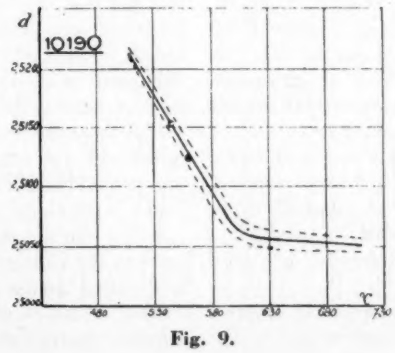


Fig. 9.

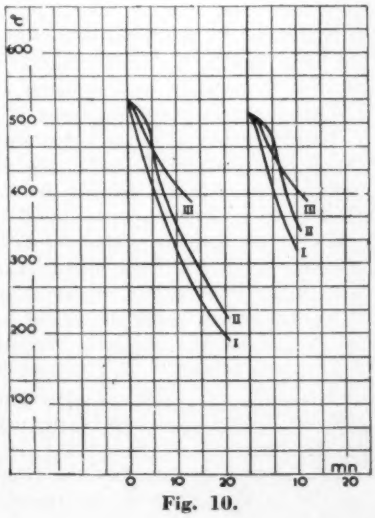


Fig. 10.

tubular furnace having an 8 cm long uniform temperature zone. The temperature was allowed to rise to 600°C. and maintained at that point for at least 20 min. Temperature was measured by a thermocouple that was in contact with the center sample. Then, the temperature was dropped to the selected stabilization temperature at the same rate as the final cooling rate that was to be used.

An example of one of the schedules used is: 600°C. for 20 min.; cooling at 5°C. min. to 530°C.; stabilization for 35 min. at 530°C.; final cooling at 5°C./min.

It should be added that the cooling rate was not maintained for more than 80 to 100°C. below the temperature of stabilization, as below 430°C. the cooling rate hardly influences the permanent birefringence. For the case of air cooling, the first drop from 600°C. to the stabilization temperature was executed by transfer from the furnace at 600°C. to another being maintained at the stabilization temperature.

In the case of air quenching from 530°C. or 510°C. to ambient temperature, the actual cooling rate was not determined as no adequate measuring equipment was available. The results obtained were simply noted.

In order to simplify presentation, the conclusions are separated from the total of experiments.

1. The Influence of Thickness. The classical law according to which the birefringence is proportional to the square of the half-thickness was verified in only two cases: (1) air cooling from 600°C. and (2) air cooling from 510°C. after 900 min. of stabilization.

2. The Influence of Cooling Rate. In some instances rapid cooling results in less birefringence than slow cooling. In one case, the variation of cooling rate caused no appreciable difference in birefringence. This experimental fact cannot be explained by the classical theory according to which the induced birefringence increases as a function of cooling rate.

However, the structural concept foresees, a priori, the possibility of obtaining a lesser birefringence for a rapid cooling rate than for a slower rate.

As indicated above, every temperature change starting from a point within the transformation region brings about a structural inequilibrium. Equilibrium tends to be reestablished more or less rapidly depending upon the temperature and the nature of the glass. The reestablishment of this structural equilibrium is rarely complete, particularly for cooling operations originated at lower temperatures of the transformation region. The closer the lower limit of the transformation range is approached, the less structurally heterogeneous a glass is once it is cooled; hence, it presents a lesser birefringence.

Thus, starting from an approximate state of equilibrium, a hypothetically instantaneous cooling of the entire bulk would cause no perturbation and, once at ambient temperature, the glass would not exhibit birefringence. Since cooling without a gradient is impossible, the final result will be a compromise of several factors, particularly thermal and structural gradients.

The structural gradient can be imagined as follows: let us assume the sample is constituted of a series of superimposed layers. This assembly is assumed to be at temperature T_1 within the transformation zone for a time sufficiently long to be in, or very close to, structural equilibrium.

Let us now assume that the temperature is dropped rapidly to T_2, outside of the transformation zone. The external thin layers are frozen in the structural state corresponding to T_1, but the center layer passed the temperature interval T_1—T_2 more slowly and its structural state, that was stable at T_1, passes a series of states of inequilibrium, each corresponding to a temperature between T_1 and T_2. For the intermediate layers, the same phenomenon occurs in somewhat attenuated form. Two cases are possible:

(A) If T_1 is close to the lower limit of the transformation zone, the rate of equilibrium is very slow, the passage of temperatures between T_1 and T_2 and the corresponding structural equilibrium states will provoke only a feeble displacement from the structural equilibrium corresponding to T_1 and the glass, once cold, will exhibit only little birefringence which will have little or no dependence upon the rate of cooling.

(B) If T_1, however, is far from the lower transformation limit, the rate of equilibrium is fast and the passage of the interval T_1—T_2 will bring about a more marked inequilibrium. The resulting birefringence can vary inversely with the rate of cooling for a given thickness.

Now let us assume the case that the glass has been for too short a period at the temperature T_1 for structural equilibrium to have been established, and that it is subsequently cooled to T_2. From the determination of the rate of stabilization, we know that the rate of stabilization diminishes in proportion to the approach to equilibrium conditions. Now, being far from the state of equilibrium, we are dealing with the case discussed above: a high rate of approach to equilibrium. In this case also, the final value of the birefringence may vary inversely with the cooling rate.

3. The Influence of Stabilization. First it should be stated that for relatively long stabilization times, when the equilibrium density is practically attained (e.g. after 300 min. at 530°C.), the birefringence is relatively weak. Also after long stabilization, but far from equilibrium density, e.g. after 900 min. at 510°C., the birefringence is relatively weak.

From the structural concept, this appears to be explained by the fact that as the glass becomes perfectly stabilized, the thermal gradient established by the cooling process can only bring about a feeble structural gradient, and consequently feeble birefringence. This holds for the case of 300 min. at 530°C.

The case of 900 min. at 510° finds an analogous explanation. Now the structural gradient is feeble not because the glass is near equilibrium, but because the rate of transformation is slow.

After examining the entire experimental evidence concerning the influence of stabilization on birefringence, we find that the birefringence after a stabilization period of 20 minutes is weaker than that after 35 min. at 530°C., or 50 min. at 510°C. In order to obtain the same birefringence at these various temperatures, one would have had to increase the period of stabilization considerably.

All these findings, which first seem to be in disagreement with the mechanical theory, have led us to resume our experiments and to increase the number of observations, with more interest centered on the phenomena occurring during the stabilization and cooling processes and on the characterization of the structural condition of the cooled sample.

One series of experiments dealt with the almost continuous measurement of birefringence and temperature

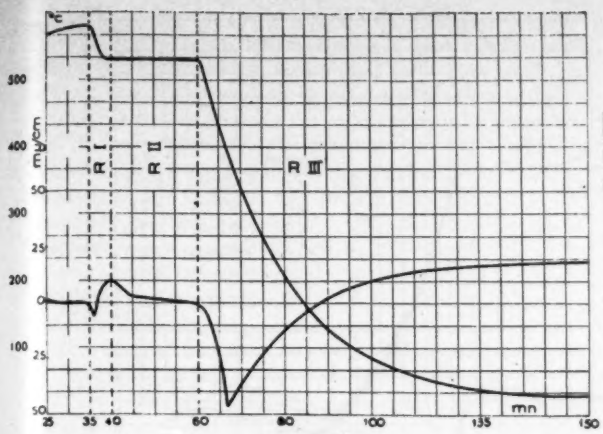


Fig. 11.

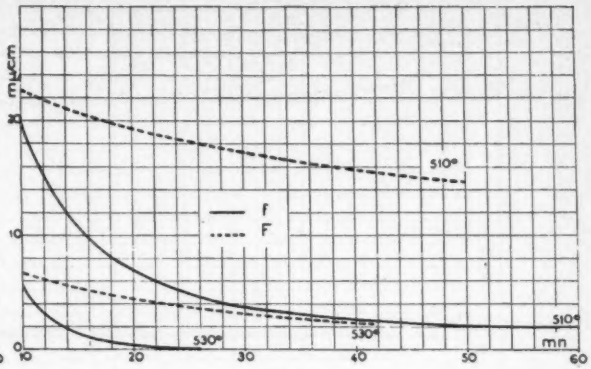


Fig. 12.

during heat treatment and of the density after the treatment. The latter measurement served to characterize the structural condition of the glass. The entire series was made with the aim to take account of the importance of the structural effect upon final birefringence and the development of birefringence during cooling.

The experiments were undertaken under the same conditions as described above except that only one thickness (10 mm.) was used. The sample was placed in a furnace permitting the measurement of birefringence during the entire cycle, including the cooling process. In addition to the sample used for the determination of the birefringence, there were two cylindrical samples, 10 mm. long and 3 mm. in diameter, which were used for the density determinations.

In this series, instead of stabilizing at 530°C. for 20, 35 and 300 minutes, and at 510°C. for 20, 50, 300 and 900 minutes, we stabilized at 530° and 510°C. for 10, 15, 20, 25, 30, 35, 40, 50 and 60 minutes. Three different cooling rates were applied, as given in Fig. 10.

The birefringence and the temperature were measured every minute above 200°C., then less frequently. The temperature drop from the "temperature of equilibration", 585°C., to that of stabilization was made as fast as possible so that the furnace was in stable condition in 7-8 minutes. The expression "temperature of equilibration" describes a temperature high enough to erase the entire thermal history. Figure 11 represents the progress of one experiment.

As in the first series, the detailed results are not presented. Instead, findings derived from the entire evidence are given, in two groups: (a) Findings based upon the development of birefringence during heat treatment and (b) Findings based on the development of the structural state.

a. Findings based upon the development of the birefringence during heat treatment. The consideration of Fig. 11 suggests its subdivision in several regions:

The region I is that of the temperature drop between equilibration (585°C.) and stabilization, which requires no further comment.

The region II is that of stabilization and relaxation in which the birefringence induced during the drop of temperature diminishes owing to relaxation. The number of experiments made allowed plotting a curve of relaxation starting from weak birefringence and comparing this curve with previously published relaxation curves that were obtained with strong initial birefringences.

Figure 12 shows this comparison and gives evidence that under the conditions applied here—i.e. starting from weak birefringence (curves f)—relaxation is achieved more rapidly than under conditions involving strong initial birefringence (curves F), the sample always being brought abruptly to the relaxation temperature.

After region II comes region III, that of cooling proper. Considering first the end of this region, i.e. the final birefringence at ambient temperature, we find that the induced birefringence does not vary ordinarily with stabilization time and with relaxation time for a given cooling rate. Presumably, induced birefringence should

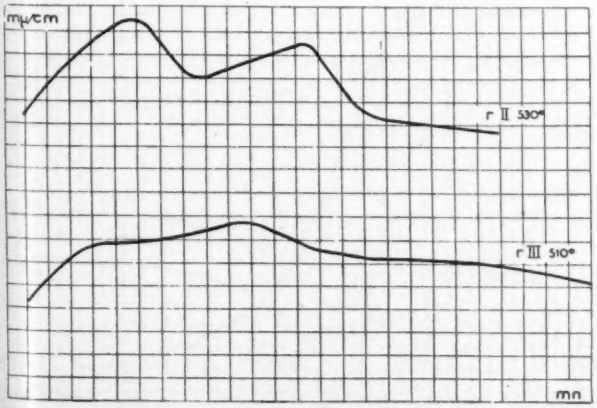


Fig. 13.

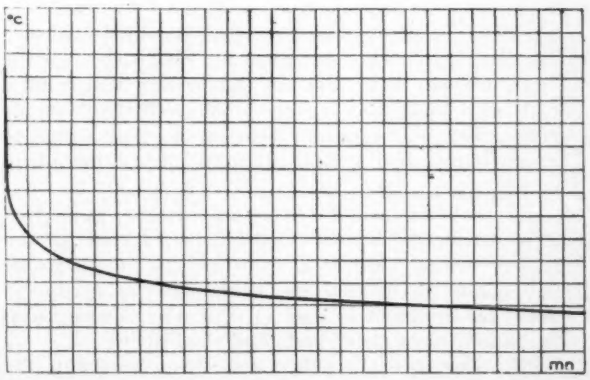


Fig. 14.

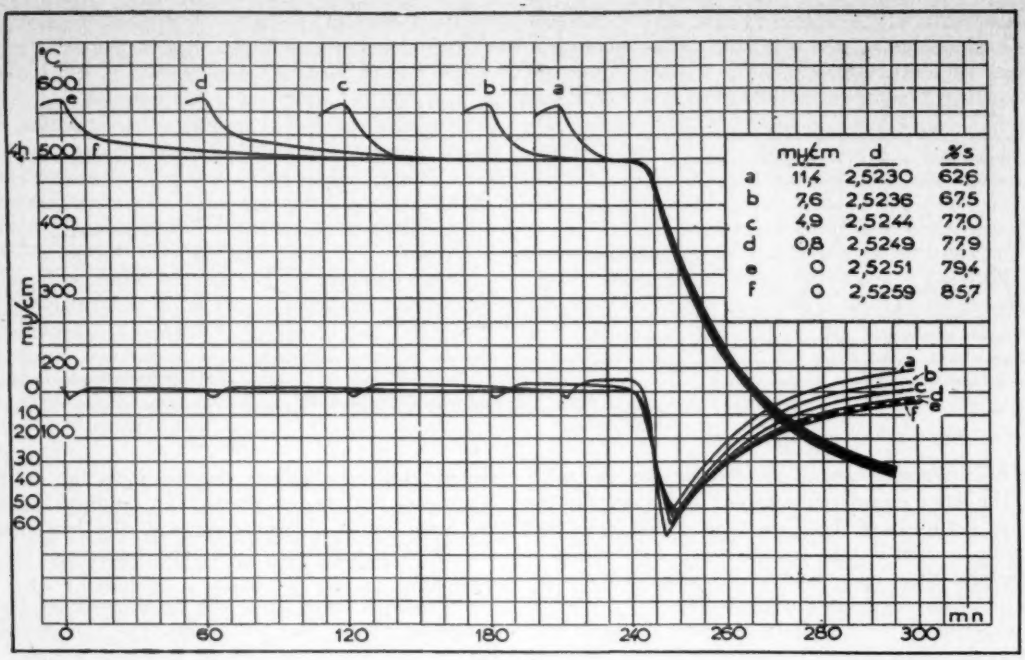


Fig. 15.

decrease as the stabilization and relaxation time was increased. On the contrary, first an increase, then either a regular decrease, or a decrease after a minimum and a second maximum (Fig. 13) is found.

Furthermore, comparing the first part of region III for different experiments (the range where the strains are reversed, i.e. where compression exists in the core of the sample), we find that the birefringence-time curves, for a given cooling schedule and different stabilization periods between 10 and 60 min., seem to represent a phenomenon more complex than a simple action resulting from a mechanical restraint (brought about by the thermal gradient) and a viscous flow, as is observed during the cooling of a glass after long stabilization.

b. Findings based on the evolution of the structural state. Examining the aggregate of the results concerning the evolution of the structural state during thermal treatment as characterized by the density of the cold sample, we first observe that the thermal treatment imposed brought the glass to a structural state slightly different from that which we obtained by bringing glass of "state 585°" abruptly to the temperature of 530° and keeping it at this temperature for the same lapse of time as during our experiments. We found a greater density, i.e., a more stabilized glass. This is normal, for while traversing the range between 585° and the stabilization temperature, 530° at a finite rate, a more pronounced structural rearrangement was produced than by the introduction of a sample tempered at 585° abruptly into a furnace kept at 530°.

We next find that, for given stabilization at a given temperature, the density varied as a function of the cooling process. We observe an increase in density as the cooling process was less rapid. Internal rearrangement was produced by cooling even when starting with an initially incompletely stabilized glass.

This observation, together with those concerning the induced birefringence, reinforces our hypothesis that the induced birefringence is heavily dependent on the variations in the structural state, therefore dependent on the structural state itself at the time when the cooling starts. In other words, the birefringence induced by a given cooling process will be the weaker as the glass is nearer to its structural state at θ_{tr}–50°C. when cooling is started.

The problem then arises of applying this statement to present practice outside the sphere of optical glasses.

At first sight, the ideal cooling curve in the annealing range (region II) would be such that the glass would always be in the equilibrium state during cooling. The curve would be obtained by plotting as abscissa the time necessary for obtaining the equilibrium at the temperatures which are plotted as ordinate. Figure 14 gives this curve for the glass examined. This curve was established proceeding from the measurements of time necessary to establish the equilibrium structure at the different temperatures after cooling from the state of equilibrium at θ_{tr}+100°C. In practice, this curve is not applicable to the present glass because of the excessive time in-

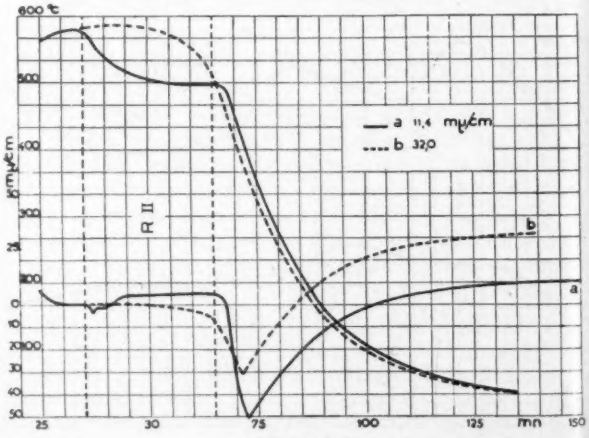


Fig. 16.

volved. But considering on one hand that it was established proceeding from the glass in its state at $\Theta_{tr}+100°C.$ and not proceeding from a whole series of intermediate states, and taking as a basis certain bibliographical and experimental data, it seems possible to shorten the time of thermal treatment. On the other hand, taking as a basis the fact that for present annealing it is not necessary to have reached the complete stabilization at the lower state, $\Theta_{tr}-50°C.$, but that it is sufficient to be in the part of the curve of Fig. 14 or of a similar curve which has only small slope, or of a similar curve, we have the following hypothesis.

The thermal treatment in the annealing range (region II) ought to follow a curve similar in form to that of Fig. 14. The curve which approaches closest to this form is the natural cooling curve between a temperature

Table I

Soda-Potash Glass

Duration of Treatment	Temp. Region of Treatment T_s—T_1	Birefringence μ/cm	Stabilization %
30 min.	540°C.–430°	0.9	53.5
60 min.	540°C.–430°	0	59
120 min.	540°C.–430°	0	63
Classical Treatment			
30 min.		14.3	46

T_s, slightly lower than the "dilatometer softening tem-

(*Continued on page* 456)

Densities of Glass

Densities Used for the Establishment of Approximate Equilibrium Curves

10 161

Density (quenched)	Density (test)	Density (stab.)
2.4897 + 0.0002 — 0.0003	2.4817 + 0.0003 — 0.0001	2.4990 + 0.0002 — 0.0001

690°	650°	620°	610°	600°	590°
2.4818	2.4820	2.4822	2.4823	2.4825	2.4831
Diff.	0.0002	0.0002	0.0001	0.0002	0.0006

Density Θ_{tr} = 2.4917; % stabilization: 46.3% $\quad \frac{2.4897 - 2.4817}{2.4990 - 2.4817}$

10 162 I

Density (quenched)	Density (test)	Density (stab.)
2.4907 + 0.0003 — 0.0004	2.4817 + 0.0003 — 0.0003	2.4990 + 0.0004 — 0.0003

690°	650°	620°	610°	600°	590°
2.4817	2.4819	2.4821	2.4822	2.4824	2.4829
Diff.	0.0002	0.0002	0.0001	0.0002	0.0007

Density Θ_{tr} = 2.4916; % stabilization: 51.5%

10 162 II

Density (quenched)	Density (test)	Density (stab.)
2.4911 + 0.0004 — 0.0004	2.4822 + 0.0002 — 0.0004	2.4993 + 0.0003 — 0.0002

690°	650°	620°	610°	600°	590°
2.4822	2.4825	2.4828	2.4829	2.4831	2.4838
Diff.	0.0003	0.0003	0.0001	0.0002	0.0007

Density Θ_{tr} = 2.4922; % stabilization: 52%

10 198

Density (quenched)	Density (test)	Density (stab.)
2.4897 + 0.0002 — 0.0005	2.4813 + 0.0003 — 0.0002	2.4951 + 0.0002 — 0.0002

710°	650°	630°	620°	610°	600°
2.4813	2.4816	2.4817	2.4819	2.4825	2.4834
Diff.	0.0003	0.0001	0.0002	0.0006	0.0009

Density Θ_{tr} = 2.4484; % stabilization: 63.2%

SCANDINAVIAN GLASS SOCIETY HOST TO INTERNATIONAL COMMISSION

For the 1954 regular meeting of the International Commission on Glass, held on June 17 at Vaxjo, Sweden, in the Stadshotellet, the relatively new Scandinavian Society of Glass Technology acted as host. The Commission meeting was followed on June 18 by a program of technical papers arranged by the Society. Social events included a dinner on June 17 by invitation of the City of Vaxjo at which the delegates to the Commission meeting and their ladies were formally welcomed by the several officials of the City and the Province; a boat excursion through beautiful Lake Helgasjon, followed by a dinner and entertainment at Evedal, a country resort restaurant on the Lake; a special luncheon trip for the ladies to Tingryd; and a dinner for all at invitation of the Society, followed by dancing, as a concluding affair on June 19.

Other events of more serious nature for the delegates included a visit on June 14 to the Hoganas-Billesholms research laboratories for ceramic and refractories research; visits on June 15 to Surte Glasbruck (glassworks) and Dr. Hedvall's department of silicate chemistry at Chalmers Technical University, Gothenburg; visits on June 17 to the Glass Institute and the Smalands Museum, both in Vaxjo; visits on June 19 to the Kosta, Gullaskruf and Orrefors glass companies; and, finally, a visit on June 20 to the National Museum of Stockholm. The meetings were well attended, with the following breakdown: Commission delegates, 30; members of the various societies, 78. Attendance of their ladies totalled 52.

B. Simmingskold, Director of Stiftelsen Glasinstitutet, Vaxjo, welcoming the delegates to the Institute.

The three glass plants visited were Kosta, Gullaskrufs Glasbruk and Orrefors. The Kosta plant, founded in 1742, is comprised of about 10 German shops producing tumblers and inexpensive stemware, in addition to art glass production. The layout is 7 pots to the furnace, with about 1,200 pounds capacity per pot. An interesting feature of this plant is a fine historical exhibit of art glass situated in an extremely attractive set of rooms designed for the purpose.

Gullaskrufs Glasbruk is a relatively new factory which made window glass from 1892 to 1922. In 1927 this company started producing domestic and art glass. About 100 people are employed and its products are sold mostly in the domestic market.

Orrefors is unquestionably the most widely known of all Swedish art glass manufacturers. Their operations are quite extensive compared to the other two plants visited and the artists include such men as Simon Gate, Edward Hald, Sven Palmquist, Nils Sanberg and Edwin Ohrstrom.

International Commission on Glass

The International Commission is a body composed of representatives of the various technical societies and institutes dealing with glass technology throughout the world. Its primary purpose is to arrange meetings that will bring glass technologists together on an international scale so they can be better acquainted personally and gain a better understanding of each other's problems and discuss the progress of glass arts and science. Such meetings are of two kinds: annual Commission meetings such as that held this year in Sweden, and Congresses such as that held last year in Venice. The former are for Commission members only, while the latter are open to all who wish to attend. It is hoped that Congresses will be held at 3-year intervals which would bring the next one in 1956.

Each member society or institute has three representatives on the Commission—its President (or his proxy) and two others nominated for three-year terms. This

Delegates to the International Commission on Glass. Front row, seated, left to right: A. Kruithof, Eindhoven, Holland; H. Lillie, Corning, N. Y.; B. Long, Paris, France; B. Dudding, Wembley, England; G. Henry, Charleroi, Belgium; H. Vandecapelle, Charleroi, Belgium; B. Simmingskold, Vaxjo, Sweden. Second row, left to right: E. Afors, Emmaboda, Sweden; C. Hermelin, Hovmantorp, Sweden; R. Touvais, Paris, France; W. Hampton, Birmingham, England; P. Mayaux, Aiseau, Belgium; T. Moriya, Tokyo, Japan; K. Sato, Tokyo, Japan; R. Gunther, Frankfurt a.M., Germany; A. Hill, Chesterfield, England; R. Allolio, Essen-Karnap, Germany; N. Von Bulow, Dusseldorf, Germany; F. Gjesmoe, Drammen, Norway; A. Mathieu, LeVesinet, France; E. Hald, Orrefors, Sweden. Third row, left to right: V. Piper, Kastrup, Denmark; J. Stevels, Eindhoven, Holland; A. Dietzel, Wurzburg, Germany; F. Klaarenbeck, Leerdam, Holland; A. Deschamps, Rhode St. Genese, Belgium; Y. Anderberg, Goteborg, Sweden; E. Borel, Romont, Switzerland; I. Peyches, Paris, France; A. Bronkhorst, Schiedam, Holland.

year the American Ceramic Society is represented by James Hackett, who serves as proxy for Ray Pafford; Howard R. Lillie, whose term extends through 1955; and Norbert J. Kreidl, whose term is through 1956. The U.S.A. is represented also by two others: G. W. Morey, as honorary member of the Commission, and J. C. Hostetter, as honorary Vice President of the Commission.

The Commission was originally started about 1930 and held two Congresses before it was temporarily suspended due to the war. It was not formally reconstituted until 1950 when a meeting was held in Berne, Switzerland, with H. R. Lillie attending as a representative of A.C.S. S. R. Scholes attended the 1951 meeting and N. J. Kreidl attended in 1952, while several from the States were present last year in Venice.

While the next Commission meeting is scheduled for Germany in 1955, plans are not yet formulated for 1956, at which time it is hoped a Congress can be arranged.

The Commission has other secondary purposes to that of its primary function which is the arrangement of meetings. Among these is the publication of a Proceedings, carrying some of the best glass research papers republished in English with resumes in other languages. The first issue of the Proceeding is now ready and can be ordered through the American Ceramic Society office at one pound sterling (about $2.85). The Commission also serves as a clearing house for information on standards, methods, etc., and has committees assigned to bring together such information on an international scale.

The business of the 1954 meeting was entirely routine in nature. It is of interest to note that a new Society of Glass Technology has been started in Italy since the time of the Congress held in Venice and was admitted to the Commission during the Vaxjo meeting.

At the start of the technical sessions, V. Piper, President of the Scandinavian Society, delivered a welcoming address in English, French and German. C. Hernelin then read a telegram to the King of Sweden giving greetings from the more than 100 assembled glassmen. A reply from the King was later received and read at the Saturday dinner. Dr. Piper extended his thanks to Commission President Dudding for his fine cooperation and announced his election to honorary membership in the Scandinavian Society.

T. Moriya and K. Sato, representing the Japanese Society of Glass Technology, presented greetings in the form of a book bearing bold face Japanese characters, which were read to everyone. B. Simmingskold, Director of Stiftelsen Glasinstitutet, Vaxjo, introduced the first paper. B. P. Dudding, of the British Society of Glass Technology, took the chair for the second and third papers, V. Piper officiated in introducing the fourth paper, and Howard R. Lillie occupied the chair for the Moriya paper.

Six excellent papers were presented at the technical sessions starting at 9 A.M. and ending at 5 P.M. the same day. While abstracts of the technical papers follow at the end of this report, brief comments on some of the papers may be of interest.

Mrs. E. Steenberg, of Stockholm, Sweden, in her review, "The Swedish Art and Domestic Glass Industry", outlined the history and development of the glass manufacturing industry in Sweden. Mrs. Steenberg stated that very little glass was used up to 1600 and that manufacture did not start until about 1650, which glass, however, was produced entirely by foreign glassmen. By early in the 18th Century, glass had become common and by 1880, exports of Swedish glassware had acquired some importance. The quality of the ware was as good as that produced anywhere, but its designs had all been copied from those of other countries. This situation continued until 1914 when strong opposition arose to the importation of foreign design ideas and Swedish artists began to develop their talents. These artists enjoyed direct contact with the glass craftsmen which resulted in a trend toward products of distinctively Swedish character. Experimental art work was brought to a peak of richness and variety so that by the 1920's, it had achieved its rightful place among the world's distinguished glassware and the industry was prosperous.

In her discussion of the present status of the Swedish glass industry, Mrs. Steenberg pointed out that the industry took root and grew up mainly around Vaxjo, in the beginning chiefly because workers were available and timber for fuel could be transported by water.

Orrefors Glass Works.

The following table showing the diversity of production, number of plants and value of ware produced will give some idea of the Swedish glass industry as it is today.

	Number of Plants	*Millions of Swedish Crowns in 1951*
Window Glass	2	15
Bottles	12	31
Lighting ware	4	6
Light bulbs	5	3
Domestic and Art.....	25	27
Miscellaneous	8	8
Total	56	90
		(About 90,000,000, or $17,000,000)

Professor J. A. Hedvall, of Gothenburg, Sweden, in conjunction with his paper "Restoration of the So-Called Sick Glasses", used some slides to demonstrate how remarkably well the material works in restoring museum glasses or enamels. This material is a derivative of methacrylic acid. He did not discuss the permanence of the coating, but it is presumed it can be renewed when necessary.

"Physiochemical Aspects of the Fining of Glass" by Dr. E. Kojenen, Karhula, Finland, was a rather extensive and complex paper. However, the speaker gave the impression that he was entirely at home with his subject and it is felt that publication of his paper in full will find an interested audience.

"Chemical Constitution of Glasses In and Near the Surface" is the title of a paper delivered in German by its author, Dr. R. Jagitsch, of Gothenburg. Dr. A. Dietzel summarized the paper in English. He stated that untreated bottles of 15% Na_2O were compared with those treated with sulphur vapor and SO_2. The untreated bottles showed up to 25% Na_2O at surface, falling to 15% at a depth of about 2,000 A.U. The treated bottles showed very low Na_2O, going up to about 15 at about the same depth.

Dr. J. M. Stevels, of Eindhoven, Holland, in the presentation of his paper, "Networks in Glasses and Other Polymers", used some interesting models (corks with linages) showing the increased flexibility of the network when the number of bridging oxygen bonds per tetrahedron falls from 4 (SiO_2 glass and crystalline SiO_2) down to 2 (chain). He discussed the use of dielectric properties at low temperatures for studying constitution. This paper will be published in full in an early issue of THE GLASS INDUSTRY.

Professor T. Moriya, demonstrating an unusual command of English, delivered his highly scientific paper, "A Theoretical Consideration of Some Properties of Glass in Transformation Range". An abstract of this paper, together with those of four others, follows.

Restoration of the So-Called Sick Glasses. *By Prof. J. A. Hedvall, Gothenburg, Sweden.*

The so-called sickness of museum glasses or enamels is a combination of weathering and crystallization. The weathering products must be removed in high vacuum and a plastic, having as far as possible the same optical properties as the glass, is sucked in to fill up cracks and holes.

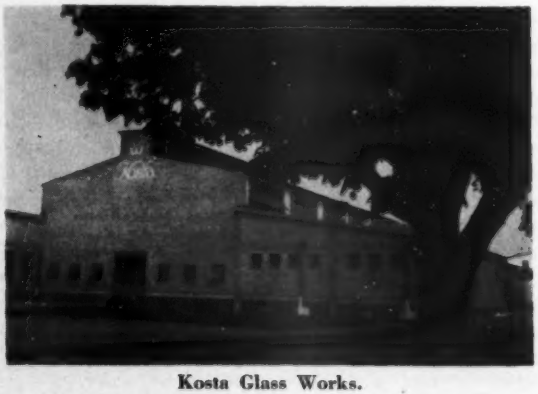
Physiochemical Aspects of the Fining of Glass. *By Dipl. ing. E. Kojenen, Karhula, Finland.*

Glass in the fining stage is a super-saturated gas solution in which both physically dissolved and chemically combined gases occur. Some estimates of the fugacities of these gases are given, based on published experimental work and thermo-dynamical calculations. The role of gas fugacities in the mechanism of seed removal, and especially in seed growth speed, bubble nucleus formation and seed resorption, is discussed.

Chemical Constitution of Glasses In and Near the Surface. *By Dr. R. Jagitsch, Gothenburg, Sweden.*

It is an old trick in the glass industry to improve the quality of the glass by introducing burning sulphur into the cooling oven. This process of imparting a "better skin" to the glass was developed technically by Surte Glasbruk and the possibility of the application of ordinary sodium-lime glasses for mechanical purposes created through superficial quality improvement.

(*Continued on page* 457)



Kosta Glass Works.

Gullaskrufs Glassworks for art glass, near Vaxjo.

GALVANIC POTENTIALS IN SILICATE MELTS

The First of a Series of
INFORMATION CIRCULARS OF THE INSTITUTE OF SILICATE RESEARCH

The observation of galvanic electromotoric forces (EMF) with glass or other fused silicates or salts as electrolytes goes back to Schweigger (1811) and Faraday (1826). Buff (1854) has been the first to build regular galvanic cells with glass as the "liquid" component. In the same year, 1854, Becquerel constructed an interesting cell in which a revolver barrel was used as one electrode, a glass tube inserted into it as electrolyte, and a Cu, Pt or carbon rod as the second electrode. The whole system was heated to full red heat, and a constant direct current flowing from the Cu, Pt or C to the Fe was observed with a galvanometer. The rule that glass is a real electrolyte, like fused salts, was clearly stated by Beetz (1854). The fundamental phenomenon of galvanic polorization in silicates, and of a distinct decomposition potential of electrolysis in glass, was also early described and carefully discussed by Warburg (1884).

It is, therefore, somewhat surprising to see that the electrochemistry of silicates has been somewhat neglected by glass physicists, although even geologists have taken a great interest in the problem of a possible participation of galvanic forces in differentiation processes in the earth's crust (Boeke 1915[1], W. Eitel, 1918[2], Niggli[3]). The material transport under the action, even of small EMFs, should, over geological periods, bring about considerable changes in the chemical composition near the conductors acting as "electrodes" in galvanic cells having the size of geological units, whether these be sedimentary layers or magmatic stocks, laccoliths, sills, and so forth.

The problems of galvanic cells with silicate melts have found practical interest recently in A. Dietzel's ingenious experiments[4] for an electrochemical explanation of the adherence of enamel layers on steel sheets. Dietzel had been encouraged to enter this interesting field of investigation by the positive results of F. Haber, 1906[5], who built up an oxygen-hydrogen cell with glass or porcelain as electrolytes for temperatures up to 1100° C. The consequent study of the phenomenon of oxidation-reduction cells, which permit numerical calculations of the EMFs on the basis of W. Nernst's osmotic theory of cells, was conducted in a fundamental investigation of the oxygen partial pressure in glass melts. (Dietzel and Csaki[6]).

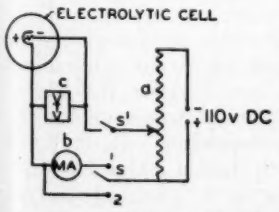


Fig. 1. Diagram of circuit for galvanic cells with glass as electrolyte: c = vacuum-tube voltmeter; b = milliameter; s/s' = single-pole double-throw switch; a = rheostat used as a voltage divider.

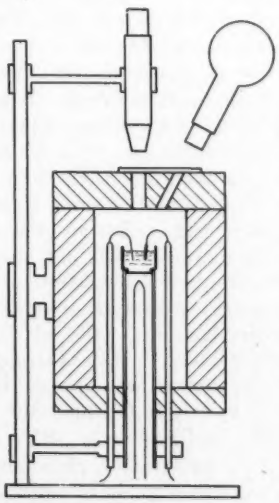


Fig. 2. Special furnace for the observation of polarization phenomenae, gas evolution in glass melts during electrolysis.

It is noteworthy that these authors in some preliminary experiments described the disturbing effects of corrosion of the porcelain material of the electrodes and of the containers by the melts (borax as a simplified electrolyte). The potentials occurring at the phase boundaries are well reproducible if the electrode material is constant (Pt). Galvanic cells of the type

(—) Pt / Zettlitz kaolin / borax melt / kaolin + quartz ceramics / Pt (+) delivered a potential of 0.063 Volts at 840°C. Differences of the chemical composition, even in different ceramic textures, gave origin to constant potentials and such cells evidently had the character of a typical concentration cell. The assumption was discussed that in the simplest case, $(AlO)^+$ions are dissolved in the melt, besides $(SiO_4)^{4-}$anions. Dietzel and Csaki concluded that the corrosion effects of glass melts on refractories should be systematically studied by electrochemical methods.

This idea was later—evidently without the knowledge of these previous experiments—followed by P. Leclerc and I. Peychès[7], who used such a concept for an explanation of strong enrichments in Na_2O near refractory (cast alumina) electrodes in an electrothermally heated glass tank furnace which indicated serious ion migration and galvanic potentials. Both authors also systematically built up galvanic cells with glass as the electrolyte, and varied the type electrofused block electrode materials submerged into the melt. The EMFs of such cells were measured at constant and variable temperatures, and, in addition to these observations, the potentials were measured in concentration cells with identical electrodes, but with variable glass compositions in contact. The conclusion was made that the typical network-forming elements in glass constitution behave in such cells as electropositive components, while the network-modifying elements behave as electronegative electrode components. The series of increasing heats of formation for the oxides is Mg — Ca — Zr — Al — Si; that of increasing electronegativities, from Ca (1) to Mg, Al, Si, O (3.5). Cells with Pyrex glass vs. alkali silicate melts showed decreasing EMFs with increasing SiO_2 content, cells of Pyrex glass vs. different R_2SiO_3 glass compositions giving a maximum of EMF for $R = K^+$. The strong alkali immigration into the refractory cathode could be made visible by using radioactive Na^{24} as tracer in autoradiographs. Leclerc and Peychès demonstrated that the use of blocks of different composition exposed to one and the same glass melt should be avoided because short-circuited cells of this kind must bring about more or less pronounced galvanic corrosion effects. A surprising rectifier effect is observed if an alternating current voltage is applied between two electrodes of different sizes. This results in a direct current flow from the larger to the smaller, with a concentration of corrosive alkali ions in the latter.

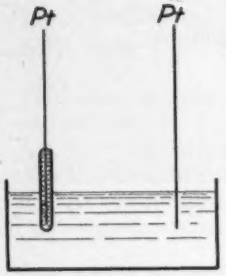


Fig. 3. Galvanic cell of the type Pt/refractory oxide/glass melt/Pt.

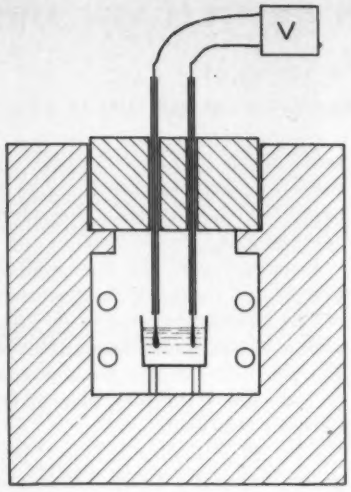


Fig. 4. Furnace with galvanic cell with glass as electrolyte.

Quite recently, the observations of the previous authors have been substantiated and supplemented by a series of highly instructive experiments of E. Plumat[8]. His conclusions are largely based on a theory of W. A. Weyl* (called "screening" hypothesis of cations, not to be confused with what Dietzel, 1943 (9), had described as a stereochemical screening of protecting alkali ions from leaching in glass) which postulates that cations of high electrostatic charges, i.e. Si^{4+} and Al^{3+}, but of low polarizability, have the tendency to reduce their exterior fields by surrounding themselves with either negative charges (electrons) or polarizable anions, e.g. O^{2-}. Chemical reactions take place if such a strong cation is enabled to improve its "screening" at the expense of ions in a neighboring phase. By "therms of energy", the attraction and repulsion forces of the ions in a given system can be formulated, e.g. in an Na-silicate glass by a series of the form $Na_2O.SiO_2 =$

$F_{Si^{4+}-O^{2-}} + F_{Na^{+}-O^{2-}} + F_{Si^{4+}-Si^{4+}} + F_{Na^{+}-Na^{+}} + F_{Si^{4+}-Na^{+}} + F_{O^{2-}-O^{2-}}$

etc. The first term is the most important for the maximum strength of the structure. It is higher in the crystalline state and lower in the fused state than the repulsive forces. If two systems are in contact, the one in which the screening state of the cations is less perfect must attract either electrons or anions from the other. An electrochemical potential will be built up, with the (+) pole in the system attracting either the anions or electrons.

* *Journ. Soc. Gl. Technol. 35.* 1951. 421-448; 449-461; 462-468; 469-486; in these publications, Weyl used the words "coordination requirements" in place of "demand for screening".

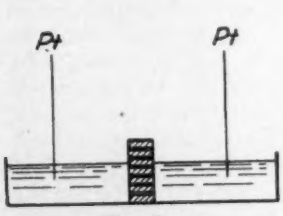


Fig. 5.

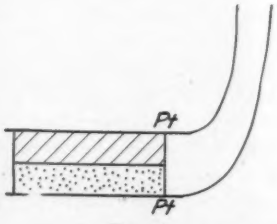


Fig. 6.

Two types of galvanic concentration cells with two glass melts as electrolytes, Fig. 5 with a refractory diaphragm and Fig. 6 for highly viscous glasses.

This highly suggestive theory is beautifully confirmed by the experiments of E. Plumat. Especially the (practically) non-polarizable cations Al^{3+} and Si^{4+} are always on the side of the (+) electrode in cells with glass as electrolytes. On the other hand, the polarizable cations Zr^{4+} and Ti^{4+} do not show a corresponding effect. The measurements of the special potentials in systematically varied concentration cells, oxidation and reduction cells, or other combinations are made with relatively simple instrumental equipment. It is only essential to have compatible resistance and impedance conditions in the cell, and the instruments for the potential determinations. In principle, the use of either quadrant electrometric instruments or electronic (vacuum tube)-voltmeters, both with high inner resistance, is recommended. The typical diagram of electric circuit, previously also used by Rindone, Marboe and Weyl[9] for electrolytic experiments and determinations of the decomposition potential by a direct current, is given in Fig. 1. For the measurement of galvanic polarization currents, a double-throw switch, s/s', is provided in the circuit to observe the intensities of these counter-currents declining with time. These instrumentations are essentially the same as those used in the classic methods of the study of the electrolysis of fused salts (R. Lorenz, 1905)[11]. An important help, however, for the study of the galvanic phenomenae with glass electrolytes was the use of a special microscope furnace in which, through a tele-microobjective, the evolution of gases, as well as other details, could be carefully observed (Fig. 2).

Some difficulties have arisen from the application of refractory oxides to the electrodes. After many not too satisfactory attempts, the best arrangement has been the following: the solid refractory material is applied on the surface of a Pt wire in very thin layers from a slurry of the extremely fine-powdered material in water. By repeated dipping of the wire into the slip, the layers can be built up to a thickness of 0.1 mm. without any drying shrinkage cracks or defects after firing in the electric furnace. This simple method is also particularly suitable because of the easy production of a great number of electrodes of well defined characteristics and compatible resistance. The cell is shown in Fig. 3 and in its definite use at constant temperatures in Fig 4.

Concentration cells are easily built up, either by separating the different liquid melts by a perforated refactory diaphragm (Fig. 5) or, if the melts are highly viscous and not easily miscible, simply by overlayering (Fig. 6)[4]. The same arrangement can also be used if solid oxide pellets are pressed together and brought to intimate contact with disk electrodes.

Of particular interest to the glass technologist is the numerical data given by Plumat for variant galvanic cell combinations. Cells of the type Pt/glass $R_2O.4SiO_2$/$R_2O.2SiO_2$/Pt showed strongly increasing potentials if the temperature was raised. Corresponding cells Pt/$R_2O.4$ or 2 SiO_2/$R'_2O.4$ or 2 SiO_2/Pt showed a higher positive potential if $R = Li^+$, $R' = Na^+$ or K^+. Cells of the type Pt/oxide/window glass melt/Pt (at 1000°C.) showed the highest positive potential for SiO_2 (about 0.15 V.), somewhat lower for Al_2O_3 (0.12 V. for Monofrax), TiO_2, SnO_2 (0.10 V.) and ZrO_2 (0.07 V.). Very characteristic is the series of the monoxides with increasing ionic radii for the cations, with the potentials BeO (+ 0.05

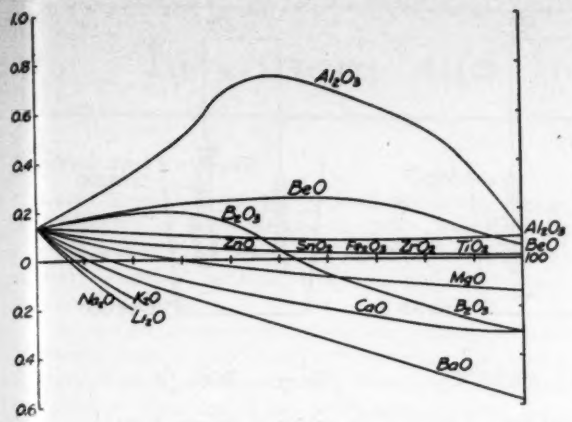


Fig. 7. Potentials of galvanic cells of the type Pt/SiO_2 oxydes (in %)/window glass melt/Pt, at 1000°C.

V.), MgO (— 0.14 to — 0.30 V., difficultly reproducible because of defects in the electrode coatings), CaO (— 0.32 V.), and BaO (— 0.62 V.).

If variable oxides are *added* to SiO_2, the potentials of the latter to a window glass melt are strongly reduced by the alkalies, less by BaO, CaO, MgO, and the higher R_2O_3 and RO_2 oxides (Fig. 7). Most particular, however, are the effects if Al_2O_3 is added to SiO_2: the curve in the graph EMF vs. molec. percentage of the added oxide shows a strong maximum about in the ratio SiO_2:Al_2O_3 = 1:1, viz. + 0.76 V. Clays, with variable ratios of these oxides, show even higher potentials to window glass melt, and their EMF data are a typical function of the firing temperatures: the lower the firing temperature was, the higher is the measured potential. Ball clays, China clays, etc., fired at 1000° have about + 0.80 V., and one ball clay, fired at only 700°, gave a potential of + 1.2 V., while the same material when fired at 1400° gave a potential of + 0.65 V. It is highly suggestive that the mineralogical composition, the role of contaminations, variations in the binding glass, etc., may influence on these highly important results. As a matter of fact, systematic additions of alkalies and RO oxides lower the potentials of the pure clays vs. window glass melts.

If a direct current is applied to the cells, a typical *decomposition voltage* (0.92 V.) and characteristic *galvanic polarization* phenomenae are observed (Fig. 8). Particularly conclusive, however, is the *gas evolution*, especially of O_2 bubbles, at the negative electrode, and the corrosion of the positive electrode if the galvanic cells are *short-circuited*. This is one of the most impressive facts in the experiments which may have a direct application also in the explanation of what in glass tanks actually occurs.

Before discussing these important details, experiments may be described in which the *reaction products* formed by the corrosion of fireclays in glass melts, and especially in the "metal line" of tanks, participate, namely in cells of the type Pt/ intact glass / modified (reaction) glass/Pt. These cells show a strong decrease in EMF with increasing percentage of refractory material dissolved in the glass melt. The potential measured near ordinary fireclays is in the order of + 0.8 to + 0.4 V., but layers of intermediate reaction glasses have regularly decreasing potentials. On the other hand, with near pure Al_2O_3 refractory (Monofrax), the potential is low (+ 0.1 V.) and that of the intermediate layers of reaction glasses higher (+ 0.3 to + 0.4 V.), but after the maximum the potentials decrease to that in contact with pure glass. On the "metal line", a particularly strong corrosion is usually observed. The potential at the three-phase boundary refractory/glass melt/air (Figs. 9 and 10) is positive to the glass (with + 0.055 V. at 1000°). Gas bubbles are usually observed in a glass layer somewhat above the interface.

Galvanic potentials in glass melts are also observed in the direction of a *temperature gradient:* the hot end is always negative relatively to the cold side, which acts as the positive electrode. Such potentials, as low as they may be, are important enough to play over long time ranges, e.g. in geological measures of the differentiation of magmatic melts, an important role in that these potentials contribute to material transport under the action of galvanic tensions. Not less important are, especially in industrial glass melts, the effects of *oxidation-reduction potentials*, e.g. in a window glass fused from carbonate and sulfate batches, with or without the addition of free carbon. These phenomenae are absolutely in parallel to those studied by Dietzel and Csaki in borax melts

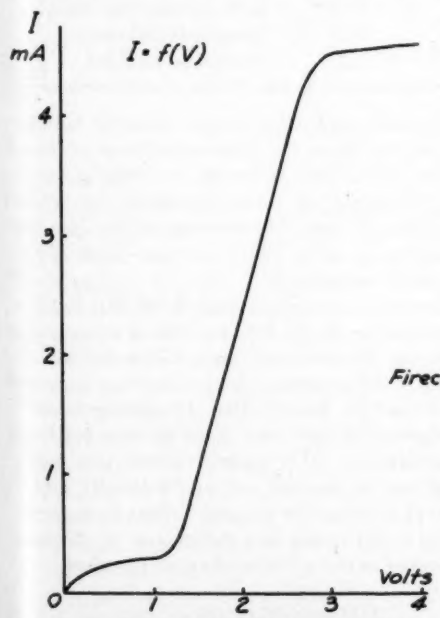


Fig. 8. Decomposition voltage determined for a galvanic cell of the type Pt/fireclay/window glass melt/Pt.

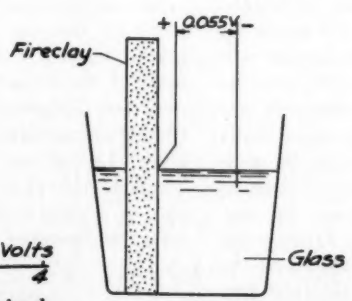


Fig. 9.

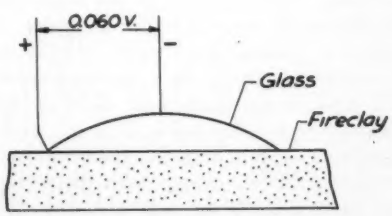


Fig. 10.

Two types of galvanic cells to show the potentials on the glass line.

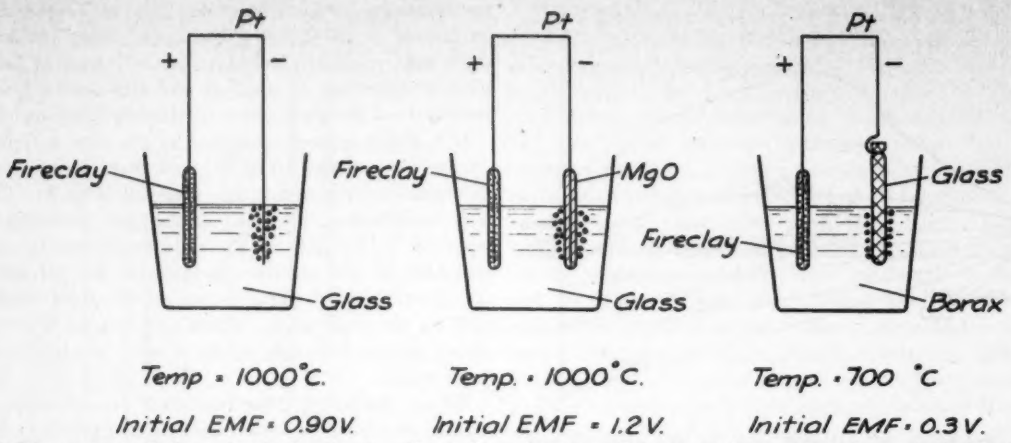


Fig. 11. Three types of short-circuited galvanic cells to show the gas evoluion near the negative electrodes in glass melts.

which contained oxides with variable valences. The higher the C addition to a window glass batch containing Na_2SO_4 (besides soda), the more the galvanic potential changes from positive values over a maximum to negative values. The possibility of controlling the "inner oxygen pressure" (Jebsen-Marwedel) of a glass melt using galvanic potential measurements in every stage of the glass fusion and fining process is therefore obvious.

We are of the opinion that Plumat's experiments on the behavior of short-circuited cells with refractory electrodes in glass melts are very well suitable for the study of sometimes rather disturbing gas bubble formations, such as reboiling, for which previously nearly no explanation could be found. Cells of the simplest kind to illustrate possible conditions in glass tanks are seen in the Figs. 11 a-c. In every case, immediately after short-circuiting, the bubbles appeared at the negative electrode and grew up to a "corn-cob"-like aggregation of even larger bubbles surrounding the refractory electrode. Some very characteristic experiments are tabulated:

Evolution of O_2 bubbles in galvanic cells on the two-phase boundaries:

Galvanic Cell	Initial EMF	Gas Evolution observed
Pt(—) /Glass at 1100°C. / Glass at 1000°C. / Pt (+)	0.1 V.	Numerous bubbles at (—)
Pt(—) /Glass melt / Fireclay / Pt (+)	0.89	Very numerous bubbles
Pt(—) /Glass melt / Fireclay, with 20% Na_2O added / Pt(+)	0.60	Numerous bubbles
Pt(+) /Fireclay / Glass Melt / SiO_2 / Pt (—)	0.84	Very numerous bubbles
Pt(+) /Fireclay / Glass Melt / MgO / Pt (—)	1.20	Very numerous bubbles
Pt(—) /Glass Melt / Silica / Pt (+)	0.19	Rather numerous bubbles
Pt(+) /Glass melt / Borax melt / Pt (—)	0.21	Numerous bubbles
Pt(+) /Glass, oxidized/Glass, reduced / Pt (—)	0.04	Numerous bubbles

In the cells with window glass melt / borax melt, the bubbles did not appear at the negative electrode but on the interface between the two melts. In general, the rate of gas evolution is a function of the EMF and of the inner resistance of the system. Interesting is also the fact that the gas analysis of the bubbles confirmed the evolution of O_2 only during the first stages of short-circuiting, while CO_2, SO_2, and probably also H_2O (the latter was concluded from the observation of bubbles with reduced inner pressures, viz. 0.5 to 0.1 atm.) appeared later. The evolution of gas bubbles in cells with a temperature gradient is not less remarkable as is the evolution of gas on both electrodes in cells with oxidized / reduced glass melts. All of these experiments, however, emphasize the great importance which the study of galvanic potentials must have in glass tank melts in contact with refractories, with the steel framework construction surrounding the hot parts of the furnace and water coolers in contact with the refractories which act as electrodes. If the cells are short-circuited (and how would that be avoided?), currents of rather great intensity must be brought into action, and these result in highly characterstic and troublesome material transfer phenomenae known from the electrochemistry of fused salt cells. The metal-line corrosion is nothing extraordinary for this group of galvanic actions and constitutes substantially the same phenomenon as the galvanic element formation in metal alloys systems which are so basically studied in metallurgy[12].

A very interesting discussion remark of Mr. LeClerc concerns the evolution of gas bubbles around an armored platinum/rhodium thermocouple dipped into the melt in a glass furnace if the armature was not isolated from the mass of the refractory lining. Also this phenomenon is doubtless in agreement with what must be expected from Plumat's experiments. It is rather certain that many other observations in practice can systematically find a corresponding illustration for galvanic effects in the complex of a glass tank furnace and its contents in all parts from the doghouse to the machine shaping the glass.

LITERATURE CITED

1. H. E. Boeke, "Grundlagen der physikal.-chem. Petrographie", Berlin 1915, p.43.

(*Continued on page* 454)

Inventions and Inventors

Feeding and Forming

Glass Charge Delivery and Forming Apparatus. Patent No. 2,669,805. Filed February 16, 1950. Issued February 23, 1954. Four sheets of drawings (none reproduced). Assigned to Emhart Manufacturing Company by George E. Rowe.

The present invention relates to the manufacture of glassware from shaped charges of hot glass which may be periodically discharged from a forehearth feeder and delivered to blank molds for preliminary forming operations prior to transfer to blow molds for the final forming operations.

The principal object is to provide a feeder-forming machine combination which is adapted selectively for either single or simultaneous multiple charge operation. When multiple charges are being handled, the apparatus provides identical paths of travel for the several charges simultaneously. The apparatus further provides delivery. The delivery apparatus provides a plurality of scoops for simultaneously receiving multiple charges wherein the same mechanism presents the scoops at the feeder for charges and also withdraws the scoops from the feeder as desired. The change from single to multiple charge operation is thus carried out with comparative ease.

The patent contains 12 claims and the following references were cited: 1,626,702, Soubier, May 3, 1927; 1,911,119, Ingle, May 23, 1933; 1,976,194, Rowe, Oct. 9, 1934; 2,081,859, Peiler et al., May 25, 1937; 2,267,236, Goodrich, Dec. 23, 1941; and 2,340,729, Barker, Feb. 1, 1944.

Glass Compositions

Television Glass Composition. Patent No. 2,669,807. Filed September 15, 1951. Issued February 23, 1954. No drawings. Assigned to Pittsburgh Plate Glass Company by John J. Smith.

A novel glass composition is given of a neutral-gray color adaptable for the production of sheet glass in con-

TABLE I

Component	1	2	3	4	5	Permissible Range	Preferred Range
SiO_2	55.23	59.26	57.67	57.84	52.43	50-63	54-57
Na_2O	10.03	23.90	18.88	22.44	22.81	1-25	1-15
K_2O	16.10	0.62	4.88	0.87	1.31	0.5-26	7-26
CaO	5.27	5.96	5.50	6.46	6.80	1-10	1-10
MgO	3.62	4.17	3.81	3.18	2.68	0-8	0-8
Al_2O_3	7.46	2.94	8.06	7.98	11.88	2-12	6-9
NaCl	0.73	0.85	0.09	0.09	0.79	0.10-1.0	0.10-1.0
Na_2SO_4	0.53	0.71	0.71	0.71	0.56	0.10-1.0	0.10-1.0
AS_2O_5	0.37	0.50	0.28	0.28	0.56	0-1.5	0-1.5
Sb_2O_5	0.37	0.99	....	....	....	0-1.5	0-1.5
Fe_2O_3	0.29	....	0.10	0.13	0.16	0.15-1.0	0.05-1.0
NiO	0.0105	....	0.02	0.02	0.02	0-0.05	0-0.05
CoO	0.0025	....				0-0.02	0-0.02
Specific Gravity (grams/cm.^{3})	2.522	2.577	2.546	2.351	2.568	.....	.....
Coefficient of Thermal Expansion (lineal) (25-300°C.)	11.71 x 10^{-6} Per ° C.	12.37 x 10^{-6} Per ° C.	11.74 x 10^{-6} Per ° C.	11.85 x 10^{-6} Per ° C.	11.74 x 10^{-6} Per ° C.	.....	.....
Temperature (° F.) at a Viscosity of $10^{3.5}$ poises.	1,970	1,760	1,865	1,860	1,895	.....	.....
Temperature (° F.) at a Viscosity of $10^{4.5}$ poises.	1,740	1,545	1,645	1,640	1,655	.....	.....
Temperature (° F.) at a Viscosity of $10^{7.65}$ poises.	1,285	1,184	1,240	1,237	1,249	.....	.....
Temperature (° F.) at a Viscosity of $10^{12.9}$ poises.	960	900	940	955	970	.....	.....
Temperature (° F.) at a Viscosity of $10^{15.2}$ poises.	860	795	840	865	875	.....	.....
Visible Light Transmission at 0.218 inch	66 ± 3%	66 ± 3%	66 ± 3%	66 ± 3%	66 ± 3%	.....	.....
Color	Gray	Clear	Gray	Gray	Gray	.....	.....
Resistivity (ohm centimeters X 10^7 at 250°C.).	6.3	....	....	....	....	.....	.....

ventional glass drawing machines and capable of sealing directly to a particular non-alloy steel.

The composition and physical properties of the preferred glasses are given in Table I on previous page.

The patent contains seven claims and the following references were cited: 1,615,448, Frank, Jan. 25, 1927; 2,504,586, Reinker, Apr. 18, 1950; 2,527,693, Armistead, Oct. 31, 1950; 2,573,855, Lyle, Nov. 6, 1951; and 2,581,639, Duncan et al., Jan. 8, 1952.

Process of Surface Finishing Glass and Article Produced. Patent No. 2,668,783. Filed October 21, 1949. Issued February 9, 1954. One sheet of drawings (none reproduced). Assigned to Anchor Hocking Glass Corporation by William J. Migley.

The object of the invention is to provide on glass bottles and the like a fine satin finish which will be attractive, durable and readily kept clean of spots and smudges.

The surfacing material is first compounded in powdered-granular form and then carefully brought to and not above the fusion point, immersed in water and ground and fluid-mixed with a powdered compound of a high melting point above the temperature of the subsequent firing. The liquid mixture is sprayed on the surface to be coated and the sprayed article is then carried through a firing lehr raising the temperature to a critical point of fusion of the coating at which the satin finish is attained and beyond which it is obscured or lost. By the controlled fusion of the composition and the admixture with the ground frit of the high melting powder, the coating is conditioned for special firing to the point of the desired satin surfacing giving a permanent decorative finish of very attractive softness and fineness of texture.

A preferred composition of the frit is as follows:

Percent	Composition, when fired gives	Frit	In preferred range in percent
39	lead oxide	PbO	30-40
27	sand	SiO_2	25-35
12	aluminum hydrate	Al_2O_3	5-10
9	lead titanate	TiO_2	1-10
4	sodium titanium silicate.	Na_2O	1-5
5	borax	B_2O_3	1-5
3	lithium carbonate	Li_2O	1-5

To each fifty pounds of the batch, eighteen pounds of water are added and six pounds of ethyl alcohol, the alcohol aiding in the suspension.

During the grinding, three to seven pounds (preferably 5 pounds) of a high melting powder, such as a barium or strontium compound (barium sulphate being an example), are added to each fifty pounds of the batch in the wet mix which is then brought to the proper consistency for spraying and is sprayed on glass containers. The sprayed articles are then carried through a firing lehr and heated to preferably 1100 to 1150°F. with the fusing period running from 5 to 15 minutes.

The patent contains five claims and the following references were cited: 748,851, Duncan, Jan. 5, 1904; 2,169,194, Geyer et al., Aug. 8, 1939; 2,225,161, Deyrup, Dec. 17, 1940; 2,397,005, Harbert et al., Mar. 19, 1946 531,146, Great Britain, Dec. 30, 1940; and *Ceramic Industry*, January 1945, vol. 44, No. 1, pages 69 and 74.

Television Glass Composition. Patent No. 2,669,808. Filed September 15, 1951. Issued February 23, 1954. No drawings. Assigned to Pittsburgh Plate Glass Company by James E. Duncan and John J. Smith.

This patent is a continuation of U.S. Patent No. 2,669,807. The preferred range of composition is changed to include the following:

TABLE I

Component	Preferred Range
SiO_2	50-63
Na_2O	15-25
K_2O	0.5-7
CaO	1-10
MgO	0-8
Al_2O_3	2-12
NaCl	0.10-1.0
Na_2SO_4	0.10-1.0
AS_2O_5	0-1.5
Sb_2O_5	0-1.5
Fe_2O_3	0.05-1.0
NiO	0-0.05
CoO	0-0.02

The patent contains five claims and the following references were cited: 1,615,448, Frank, Jan. 25, 1927; 2,504,586, Reinker, Apr. 18, 1950; 2,527,693, Armistead, Oct. 31, 1950; and 2,581,639, Duncan et al., Jan. 8, 1952.

Copper Ruby Glass. Patent No. 2,672,423. Filed May 12, 1950. Issued March 16, 1954. No drawings. Assigned to Owens-Illinois Glass Company by E. M. Lobdell and J. W. Wright.

The invention relates to the art of making copper ruby glass. Copper ruby glasses have been made for many years past, using batch formulas including charcoal or cream of tartar as a reducing agent. With such reducing agents, difficulties are encountered, particularly in controlling and maintaining uniformity of color. Coal, ground to a suitable fineness and in suitable quantities, may be used advantageously as a reducing agent in the manufacture of copper ruby glass. The use of bismuth in small amounts in combination with the coal to maintain and control uniformity of color of the glass is desirable. The following is a sample glass batch formula:

	Formula		Per cent
Sand	2000	SiO_2	71.92
Soda Ash	796.8	Al_2O_3	1.78
Calcite Limestone .	508	Fe_2O_3	.039
Feldspar	252.8	TiO_2	.013
Powdered Coal ...	16	CaO	9.32
Cuprous Oxide ...	2.4	MgO	.09
Stannic Oxide	6.4	Na_2O	16.53
Bismuth Subnitrate	3.6 to 6.8 oz.	Cu	.071
		SnO_2	.213
		$Bi2O_3$	.006 to .011

To produce the desired color, the temperature may be temporarily raised somewhat higher than the usual annealing temperature, for example, up to about 1000°F.

The patent contains 2 claims and the following references were cited: 2,174,554, Dobrovalny et al., Oct. 3, 1939; and 2,233,343, Dobrovalny et al., Feb. 25, 1941.

Glass Compositions

Colored Glass Fiber Products. Patent No. 2,671,033. Filed March 15, 1952. Issued March 2, 1954. No drawings. Assigned to Owens-Corning Fiberglas Corporation by J. H. Waggoner.

This invention aims to produce glass fibers which may be given a permanent color in an economical and practical manner and to provide a method for manufacturing the same. Glass fibers arranged in strand or fabric form are treated with an organo metallic compound capable of producing a colorless or relatively white reaction product upon decomposition at high temperature on the glass fiber surfaces. The surfaces then becomes highly receptive to conventional coloring agents or are able permanently to be colored by conventional means with ordinary coloring materials, such as pigments and dyes.

The salts which may be used in carrying out this invention are the salts or compounds in which, tin, zinc, aluminum, titanium and zirconium is a component. For example, organic metallic salts of tin, such as stannic naphthenate, stannic resinate, stannic benzoate, stannic octate, stannic salts of other aliphatic and aromatic acids, and stannic salts or soaps of fatty acids of the type oleic acid, stearic acid, palmitic acid, and the like, may be used.

Best results are secured with concentrations of about 1-5 percent by weight. The coated fibers are then heated to a temperature above 600°F. for a few minutes to form the reaction production on the glass fiber surfaces.

The patent contains 17 claims and the following references were cited: 2,436,304, Johannson, Feb. 17, 1948; 2,563,288, Steinman, Aug. 7, 1951; 2,584,763, Waggoner, Feb. 5, 1952; 2,693,817, Waggoner, Apr. 22, 1952; 2,608,499, Straka, Aug. 26, 1952; and 559,068, Great Britain, Feb. 2, 1944.

Glass Fiber Twine. Fig. 1. Patent No. 2,671,306. Filed April 12, 1951. Issued March 9, 1954. Two sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Games Slayter.

The manufacture of strong, tough twine utilizes glass fibers in the form of balls or spools of coated glass fiber strands. Each strand of the glass fibers, as it is manufactured, may consist of 200 or more individual fibers of very fine diameter. A sufficient number of balls 10 or similar supply of continuous strands of glass fibers are assembled and shown in Fig. 1. Each of the strands or groups of strands is led from the interior of the spool through a feeding eye 11 and associated with other strands into a ribbon-like group 12. The ribbon of strands is led over rods 13 and 14 to equalize the tension and then through a comb 15 for spacing.

After the strands are associated and led through the comb 15, a mass of glass fiber strands is formed into an orientated flat ribbon 16 which is led into contact with the upper surface of a tape 17, fed from a supply roll 18. At the junction point of the tape 17 and ribbon 16, a roller 19 serves as a support and a drip nozzle 20 may be provided to spread a coating of adhesive from a supply tank 21 over the surfaces of the tape 17 and ribbon 16 of strands. Adhesives for this purpose include high softening point asphalt, butadiene acrylo-nitrile copolymers, polyvinyl acetates, natural or synthetic rubber latexes.

The tape 17 may be made of any type of fibrous material, such as "Kraft paper", cloth or cellulose fibers. The ribbon 23 then passes through a steam chamber 24 where the heat softens the adhesive and the moisture softens the fibers of the tape 17. The structure then is led to a twisting and balling machine 25 which is operated at a speed selected to twist the flat ribbon 23 into the finished cord.

The patent contains 11 claims and the following references were cited: 2,176,019, Cohoe, Oct. 10, 1939; 2,293,246, Fay, Aug. 18, 1942; 2,523,022, Harstman, Sept. 19, 1950; and 2,604,424 Mathes, July 22, 1952.

Sheet and Plate Glass

Glass Drying Apparatus. Fig. 2. Patent No. 2,671,241. Filed August 23, 1947. Issued March 9, 1954. Three sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by J. E. Starner.

The invention relates broadly to glass cleaning apparatus and more particularly to an apparatus for drying bent or curved sheets or plates of glass. An important object of the invention is the provision of improved apparatus wherein the efficient drying of bent glass sheets or plates of different curvatures may be accomplished rapidly and conveniently in a substantially continuous manner as the sheets or plates are carried forwardly on edge in a substantially vertical position.

Referring to the drawings, Fig. 2, there is illustrated a tunnel-type housing, generally indicated at 10, which is

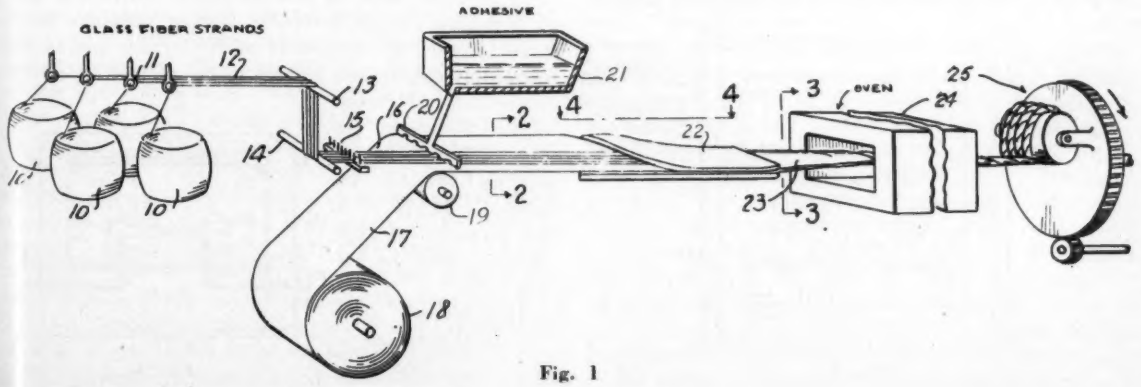


Fig. 1

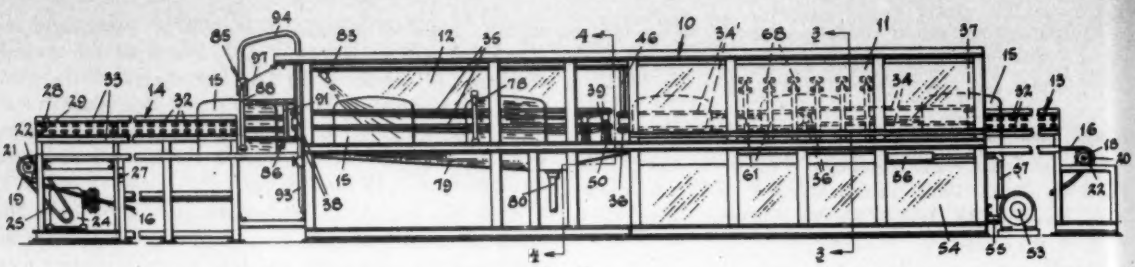


Fig. 2

divided into a washing zone or compartment 11 and a rinsing zone or compartment 12. Extending from opposite ends of the housing 10 are horizontal track supporting frames 13 and 14, the frame 13 being arranged at the entrance end of the washing compartment 11 to receive the glass sheets 15 to be cleaned, while the frame 14 is arranged at the exit end of the rinsing compartment 12 for supporting the glass sheets as they are removed to a point of inspection and packing. The spray nozzle 83 is positioned to a direct discharge of water toward the upper edge of the glass sheet and rearwardly at an angle, causing the moving sheet or sheets of glass to pass through a "curtain" of water to further flush the surfaces. As the glass sheet 15 emerges from the rinse compartment 12, the opposite surfaces are subjected to a blast of air which acts to dry the sheet surfaces.

The apparatus is of relatively simple construction and it can be operated rapidly and conveniently to effect a thorough and efficient washing and drying of the glass.

The patent contains 5 claims and 12 references were cited.

Glass Bending Apparatus. Fig. 3. Patent No. 2,671,987. Filed September 13, 1951. Issued March 16, 1954. Three sheets of drawings. Assigned to Libbey-Owens-Ford Glass Company by J. E. Jendrisak.

A novel method of bending glass is disclosed in Fig. 3 in which movable burners are used to create and control localized zones of heat concentration. It has been found that the burners 22 can be located for heating of glass sheets during their bending to a special curvature by moving the burners in and out and up and down above a sheet carried in the customary manner on a hinged bending mold in its open mold position. Upon movement of the carriage 31 along the base 30 or movement of the burner unit 32 relative to the carriage, the generally desired position of the burners can be obtained in a line transverse to the movement of the mold through the furnace. In adjusting the position of the burner 22 with reference to its elevation above the glass sheet, it may become necessary to not only swing the burner unit 32 upwardly or downwardly by means of gear sector 75 and rack 102, but to reciprocate the unit 32 within the carriage until the desired positional elevation is reached. If the positions of the carriage on the base, the burner unit on the carriage and the pair of plates 45-46 relative to the upper pair of plates 43-44 are checked on their respective scales, the position of the burner 22 inside the furnace can be exactly determined and a permanent record made of the same. Should it be necessary to produce a second type of curvature, the burners are moved into new positions.

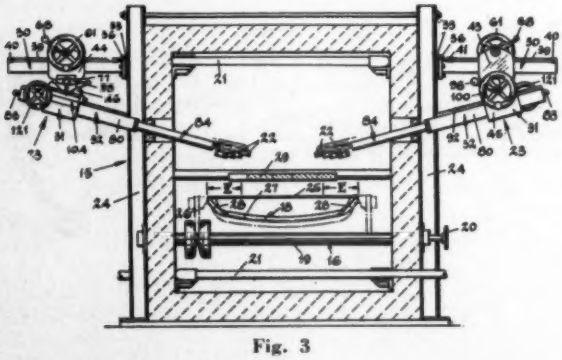


Fig. 3

By employing mounting assemblies, as described, it is now possible to achieve the heating of glass sheets, prior to their bending, in selected areas and with a definite positioning of localized heating burners above the selected areas.

The patent contains 19 claims and the following references were cited: 1,188,951, Lacerda, June 27, 1916; 2,125,176, Jones, July 26, 1938; 2,423,188, Herbst, July 1, 1947; 2,450,297, Pearse et al., Sept. 28, 1948; 2,452,483, Paddock et al., Oct. 26, 1948; and 2,460,826, Hooser, Feb. 8, 1949.

Furnace for Bending Glass. Fig. 4. Patent No. 2,671,988. Filed December 26, 1950. Issued March 16, 1954. One sheet of drawings. Assigned to Libbey-Owens-Ford Glass Company by E. L. Walters.

The rectangular furnace 7 in Fig. 4 is heated by a plurality of U-shaped heating tubes 21 extending transversely across the furnace adjacent the top 14, the ends of these tubes extending through the sidewalls 12 and 13 of the furnace. Each conveyor roller 15 is fitted with a pair of conical collars 19, the collars defining a track for one of the legs of the mold frame 20 for guiding the mold frames along their intended path.

In order to furnish additional heat, directed particularly to those areas of desired greater curvature, there is provided elongated tubular heating members 24 located adjacent the bottom 11 of the furnace and extending longitudinally and parallel to the path of the molds. Each tube 24 comprises transverse sections 25 and 26 extending through the sidewalls 12 and 13 of the furnace and adjacently parallel the bottom.

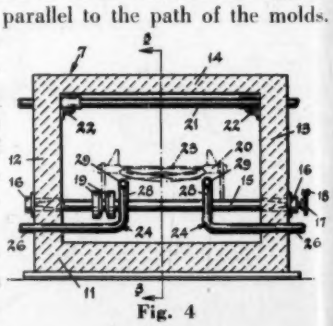


Fig. 4

The relative posi-

(*Continued on page* 452)

Some Mechanical Problems of Glass Presses

Where it is considered that glass pressing is one of the oldest forms of glass fabrication, it is surprising that so little technical reference is found on the subject in the glass literature. Recently, two articles dealing with the subject have appeared in the technical press. One of these (N. A. Nichols, "Some Mechanical Problems of Glass Presses", *Journ. Soc. Glass Tech.*, February 1954) deals with various factors which influence the pressing of glass.

Some of the important factors in pressing are: (1) the correct weight of glass in the gather or gob; (2) the correct temperature; (3) the correct placing of the glass in the mold; (4) the speed at which the glass is brought under the press head; (5) the speed of pressing; (6) the pressure applied; (7) the dwell time or time of contact of the plunger with the glass; (8) the time of contact of the finished article with the mold. In either hand or automatic presses, these same factors operate, though the methods of achieving them are different.

That the correct weight of glass gathered or fed to the machine is of prime importance is obvious, yet achieving that end is not quite so simple. In hand operations, it depends upon skill. Even an automatic feeder does not give correct weights always and the operator can make or "break" the job by neglecting the weight. Unless the correct weight of glass is repeatedly delivered, all subsequent work is foredoomed to failure.

The importance of temperature cannot be overstressed for it is the temperature-viscosity relationship which makes glass so different from other materials. In pressing some borosilicate glasses, the viscosity can change from 2000 to 10,000,000 poises in 4½ seconds from the time of gathering to the completion of the pressing operation on an automatic machine, or from 10,000 to 10,000,000 poises during the pressing operation itself lasting less than 1½ seconds. The skin of the article immediately after pressing must be almost rigid, while the center portion of the glass may still be comparatively soft.

The gathering temperature for a borosilicate glass can vary from, say, 1400° to 1150°, depending upon the process employed. For normal soda-lime-silica glasses, the range is 1200°-1000°, again depending on the article and process used. The viscosity of a borosilicate glass of the Pyrex type is at 1400°, in round figures, 1800 poises and at 1150°, 20,000 poises, i.e., it is eleven times as viscous at 1150° as it is at 1400°. This has its effect on the pressure required, which will be roughly proportional to viscosity. For example, on a hand press making a certain article, the mean temperature of the glass in the mold awaiting pressing was 1330°; a similar article being made on an automatic machine had glass in the mold at 1165°. The ratio of viscosity was, therefore, 6:1. The net pressure on the hand press was about 2460 lb. whereas it was 15,000 lb. on the automatic press.

The gathered glass must be placed deliberately—as opposed to dropped—into the mold. Good gob laying is very important, often making the difference between a 25% and a 75% pack. Sometimes the glass is placed deliberately off center. At other times, central loading is essential, but the shear cut is placed at the side. In rectangular molds, the glass is laid along the longitudinal axis. For best results, the glass must be placed correctly in the mold.

The mold thus loaded is brought under the press head for further manipulation. While all this is taking place, the glass is rapidly losing temperature so that the longer it takes, the colder will the glass become and the more difficult to work. At this point in the process, the mechanical parts of the press begin to do their work.

The introduction of the spring cage meant that one ring could be used for several bodies, and it could either be loose or "hung up", thus avoiding much hand manipulation. In the 18-inch side-lever press, the pressing mechanism is simple, yet most effective. It consists mainly of a lever, a crank or quadrant plate, and balance weight, a connecting rod, crossheads and guides, and the plunger and spring cage.

Every job has its own particular set-up and, from experience, the presser knows approximately where to set his cage and crosshead. Adjustments are almost always made when the equipment has warmed up.

The primary purposes of the springs are to hold the ring down when the glass is pressed up, and to hold the article down when the plunger is released. They are used as well, however, to control the pressure exerted by the man on the glass, and also to send the lever back when pressure is released (commonly known in practice as "the spring") with a tight press. The greater the compression on the spring, the harder a man has to work. Considering this point of view only, if too little compression is used, then the operator loses some "feel" of his press and he has overpressed the article without even trying; the glass either forces the ring up or is crizzled. When the glass is very soft, less mechanical advantage (or "stretch" as it is frequently called in practice) is required and more compression on the spring. If there is too much compression on the spring, the operator cannot press the article up at the correct weight. A man's dead weight does come into the picture too; a heavy man needs more compression than a light one. Four different average-sized men making the same article in a soda-lime-silica glass varied from ¾ inch to 1¼ inches "spring", corresponding to an approximate force of 1300 lb. and 2160 lb., respectively. As far as the eye could see, all their connecting rods were set to the same angle.

Every presser has his own special method of working, which can vary considerably, yet all produce satisfactory results. As the crank approaches bottom dead center, the mechanical advantage tends to infinity. At the same time, the plunger movement tends to zero. The correct working position must be found, since it is no use having a large pressing force available if you cannot displace any glass.

The setting of the press must be carefully carried out.

In hand pressing, the operator does not really begin to apply his weight until the ring touches the mold and the springs begin to operate, say at a 145° crank angle, a one-inch compression of the spring and a mechanical advantage of 25. He then grades his pressure to suit the conditions of the work, the press setting and the temperature. He can *feel* when the article is pressed up. The lever, already moving quite slowly, stops as if coming up against something hard, although this depends very much on the type of article being pressed. Then the pressure can be maintained, instantly released or the plunger merely held in contact with the glass so as to aid in the setting of the glassware.

On an automatic machine, this last is known as "dwell time". The thicker the article, the greater the dwell time needed. This sensitivity of touch is denied to the automatic-press machine operator, and he has not nearly the flexibility of the hand operator. Neither can he merely hold the plunger in the glass. An automatic press *must* be either pressing or removing the plunger. This implies that the margin between glass which is not set and that which is crizzled and over-pressed is much narrower in the case of automatic pressing; a variation of 1/10 second on an automatic press is a significant change in dwell time. These times are quite small; for 16-oz. articles the dwell times vary up to 0.34 second, and for 70-oz. articles up to 1.22 second.

The snags encountered in the normal side-lever press have been overcome to some extent in the offset side-lever press. In the example to be considered, the crank center is offset 2½ in. behind the center line of the columns. Virtually this has the effect of chopping off the extremities of the travel curve and mechanical-advantage curve.

The press is set so that at the end of the pressing stroke when maximum force is to be exerted, the connecting-rod is vertical and in line with the center line of the columns. This means that there is no side-load on the columns and no deflection, as occurs with the ordinary side-lever press. It does limit, of course, the mechanical advantage, and hence the pressing force available is reduced. Yet in the example quoted, a mechanical advantage of 31-4 is still available, corresponding with a pressing force of 3140 lb. for a 100-lb. pull.

This loss of power is compensated by a different method of holding the ring on to the body. Instead of the usual spring cage, a cam lock is used so that there is no power absorbed in spring compression (1732 lb./inch of compression in the case of the 18-in. side-lever press just described) and the presser applies his efforts solely to the glass. This is particularly valuable in deep pressings, where the plunger has a long working travel. The press can accommodate an article, say, 6½ inches deep. Since the working range is over the less steep section of the mechanical advantage curve, good control results.

The toggle press employs a very old mechanism used in all kinds of machines. Like the side-lever press, and certain eccentric cams and locking devices, it depends on the basic fact that as $\theta \to 0$, $\frac{1}{\sin \theta} \to \infty$, θ being the angle between the moving and fixed member. Normally, the simple toggle consists of two links. The effort is applied to the central point and the final power obtained at right angles to the direction of this force. As the links straighten, $\theta \to 0$ and the power increases rapidly, tending to infinity. The Lynch-type toggles are a development of this action.

Since the mechanical advantage changes as the inverse of the plunger movement, the mechanical advantage tends to infinity as the plunger movement tends to zero. As in the hand-operated press, a large force is no use if there is no accompanying glass displacement, so the last 2 inches of piston movement are of little value. It is often arranged, therefore, that the piston stroke is limited so that the short center link never becomes horizontal, and the toggle spread is therefore limited too. The Lynch-type toggle links can never become straight, because the fixed center of the toggle links is 25 inches and the two short links together with the piston crosshead only measure 23 inches. The limitation in toggle spread, and hence in mechanical advantage, is very necessary to prevent damage to the table or columns or threads on the cylinder-end and nuts. At 22½ inches toggle spread and only 30 lb./sq. in. air pressure (action and reaction being equal and opposite), the total stress on the column and table is 54,250 lb. or 24.2 tons. This excessive force causes the levelling wedge to slip out sometimes, and damage may ensue to the tilted table. This limitation of mechanical advantage of the toggle corresponds to the limitation incorporated in the design of the offset hand press, which avoids broken crossheads and deflected columns by limiting the crank angle and setting the press so that the connecting-rods are in line with the center line of the columns.

The choice of working limit of toggle spread is purely arbitrary. The factors to consider are the rate of change of mechanical advantage, the travel required of the plunger during the actual pressing and the general sensitivity of the set-up.

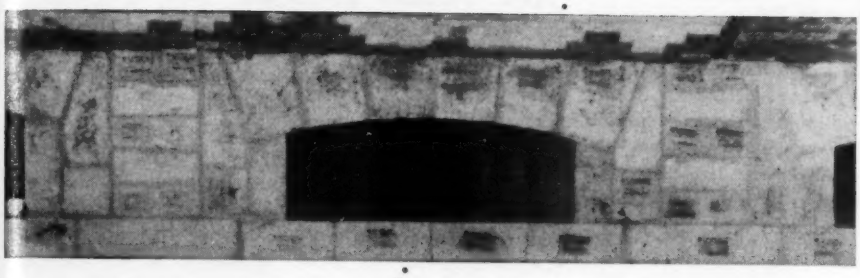
When the article is not pressing up, more pressure is required, and so the cylinder and top crosshead are lifted thus increasing the toggle spread and mechanical advantage. The thread on the cylinder of this particular machine is three to the inch, so that only a quarter of a turn of the nuts would raise the cylinder 1/12 inch (0.083 inch), giving a plunger travel of 0.127 and a mechanical advantage of 7.87. At 30 lb./sq. in. air pressure, the plunger force will now be 26,700 lb. or 11.95 tons, as against 8.45 tons. Thus for a movement of only 83 thousandths of an inch, the pressure has increased by 3½ tons! This point can easily be proved in practice, and operators of mechanical presses should restrain themselves or be restrained by others from altering this setting without good reason. It corresponds to the sensitive setting of the hand press. This example also emphasizes the need for complete interchangeability of equipment and tight tolerances on mold parts. If this is not done, then it takes much longer to settle down again if, say, a plunger and ring are changed which are but slightly different in length from the one previously used.

On an automatic press, crizzles, bad joints, glass between the ring and plug, or ring and body, are caused only too easily by over-pressing. The operating position of the links is very closely tied up with the glass temperature and viscosity. If the viscosity is doubled, then in round figures the pressure required to press the article is doubled. As an example, a particular article was pressed automatically under one set of glass-temperature

(*Continued on page* 458)

The trend is to **MONOFRAX®**

FUSED CAST
refractories



TO AVOID SUPERSTRUCTURE RUNDOWN
it's essential to use refractories with a really low percentage of glassy phase. For, as you know, this matrix will ooze and become a possible source of stones and cords. What's more, the exposed crystals either flake off into the tank or become part of the drip.

The answer is to use MONOFRAX H fused cast refractories. This material is practically devoid of glassy matrix. It's over 99% beta alumina, and has less than 0.5% interstitial glass! Hence, there is far less chance of honeycombing, bleeding, and spalling. You have a virtually dry superstructure. And there's less chance of eutectic formations from the batch dust.

JUST ORDERED — An operator of a container glass tank, melting Georgia green, has just ordered MONOFRAX MH refractories for the top course melting end sidewalls, full depth bridge wall, and backwall. In the superstructure he will use MONOFRAX H tuckstones, port bottoms, breast walls, port jambs, port arches, port neck sidewalls, and burner blocks. He anticipates longer block life, lower refractory costs and improved glass quality, which were the main reasons for selecting these fused cast products.

[redacted]

Dept. L-84, Refractories Division
The Carborundum Company, Perth Amboy, N. J.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during May 1954 was as follows: *Flat Glass:* A drop of 2.4 per cent was indicated by the preliminary employment figure of 24,400 for May when compared with the previous month's 25,000 employment. *Glass and Glassware, Pressed and Blown:* During May, employment was a preliminary 77,900. This is a difference of only .6 per cent from the adjusted 78,400 employment reported for April. *Glass Products Made of Purchased Glass:* A preliminary figure of 13,200 employment was reported for May. When compared with April's adjusted 13,700, a drop of 3.6 per cent is shown.

Payrolls during May 1954 were: *Flat Glass:* A preliminary payroll figure of $9,990,743 was reported for May. This is a drop of 4.7 per cent from the $10,486,667 reported for the previous month. *Glass and Glassware, Pressed and Blown:* During May, payrolls were reported to be a preliminary $23,636,418. When compared with the previous month's adjusted $23,421,216, an increase of .9 per cent is indicated. *Glass Products Made of Purchased Glass:* According to preliminary figures, payrolls were $3,389,100. This is 6.2 per cent below the adjusted $3,613,913 reported for April.

GLASS CONTAINER SHIPMENTS
((All Figures in Gross)

Narrow Neck Containers

	June, 1954
Foods	1,037,000
Medicinal & Health Supplies	1,005,000
Chemicals, Household & Industrial	800,000
Beverages, Returnable	1,126,000
Beverages, Non-returnable	142,000
Beer, Returnable	379,000
Beer, Non-returnable	855,000
Liquors	689,000
Wines	344,000
Toiletries & Cosmetics	684,000
Sub-total (Narrow)	7,061,000

Wide Mouth Containers

Foods	*2,641,000
Dairy Products	214,000
Medicinal & Health Supplies	487,000
Chemicals, Household & Industrial	171,000
Toiletries & Cosmetics	222,000
Packers' Tumblers	162,000
Sub-total (Wide)	3,897,000
Total Domestic	10,958,000
Export Shipments	204,000
TOTAL SHIPMENTS	11,162,000

* This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY
(All Figures in Gross)

		Production June 1954	Stocks June 1954
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	7,032,000	8,520,000
	Wide Mouth	*4,187,000	*5,188,000
Dairy Products		205,000	318,000
Beverages, Returnable		1,026,000	1,410,000
Beverages, Non-returnable		174,000	198,000
Beer, Returnable		344,000	419,000
Beer, Non-returnable		806,000	852,000
Liquors		698,000	975,000
Wines		325,000	439,000
Packers' Tumblers		175,000	175,000
TOTAL		11,219,000	13,708,000

* This figure includes Fruit Jars and Jelly Glasses.

Glass container production, based on figures released by the Bureau of Census, dropped off a little during June 1954 to a total of 11,219,000 gross. Compared with the May production of 11,548,000 gross, a drop of 2.8 per cent is shown. During June 1953, 10,850,400 gross of glass containers were produced, which is 3.3 per cent less than for June this year. At the end of the first half of 1954, glass container manufacturers have produced a total of 63,992,616 gross. Compared with the 61,132,942 gross produced during the corresponding period in 1953, production is 4.6 per cent higher this year than last.

Shipments of glass containers during June 1954 continued on the upswing and were reported to be 11,162,000 gross. During May 1954, shipments were 11,071,000 gross, or .8 per cent less than for June. Shipments of glass containers during June 1953 were 10,420,615 gross. This is 7.1 per cent less than for June 1954. During the first six months of 1954, manufacturers have shipped a total of 61,062,195 gross of glass containers. When compared with the 60,417,213 gross shipped at the close of the first half of 1953, it is indicated that 1954 is running 1 per cent ahead of 1953.

Stocks on hand at the end of June 1954 were 13,708,000 gross. This is a drop of only .2 per cent from the 13,745,000 gross on hand at the end of May 1954 and 33.5 per cent above the 10,261,051 gross on hand at the end of June 1953.

Automatic tumbler production dropped 6.9 per cent during May 1954 to 5,650,544 dozens. Production during April was 6,074,989 dozens, and during May 1953 it was 6,049,345 dozens. Shipments during May 1954 were 6,225,429 dozens. This is an increase of 1.2 per cent over the 6,151,542 dozens shipped during April. During May 1953, shipments were 5,950,792 dozens. Stocks on hand at the end of May 1954 were 9,296,925 dozens, which is 5.6 per cent under the 9,852,150 dozens on hand at the end of April. Stocks at the end of May 1953 were 10,704,873 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during May 1954 were 2,987,257 dozens. When compared with the previous month's sales of 3,148,476 dozens, a drop of 5.1 per cent is shown. Sales during May 1953 were 3,532,555 dozens. At the close of the 12-month period ending May 1954, manufacturers had sold a total of 37,518,463 dozens. This is 10.4 per cent below the 41,906,412 dozens sold during the corresponding period in 1953.

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FOR *Pottery and China*

- Body Stains
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FOR *Porcelain Enamel*

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- Uverite
- Chemicals for Mill Additions

FOR *Glass*

- Enamels
  - Dry
  - Paste
  - Thermo-plastic
  - In Spraying Vehicle
- ACL Colors
- Liquid Bright Gold
- Screening Gold
- Cadmium Sulphide Orange
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- Harshaw Ceramic Materials (16 page book)
- Glaze Stains Color Card
- Flamingo Pink Color Card

G.C.M.I. ESTABLISHES NEW LABOR RELATIONS DIVISION

The Glass Container Manufacturers Institute, Inc., has established a new Labor Relations Division which will, among other things, handle joint collective bargaining for the manufacturers of glass containers, as well as for other segments of the glass industry, it has been announced by Victor L. Hall, General Manager.

Named to head the new division is Ralph A. Lind. As a consultant on labor relations, Mr. Lind has been working with G.C.M.I. for the past 17 years. Prior to that, he was regional director of the National Labor Relations Board in the Ohio-Indiana area.

The new G.C.M.I. Labor Relations Division will also serve other segments of the glass industry, Mr. Hall stated, announcing that the National Association of Manufacturers of Pressed and Blown Glassware has also established a Labor Relations Division similar to the Institute's, and that the two units will be headquartered at G.C.M.I. under Mr. Lind's direction. John H. Morris, who has been associated with the National Association of Manufacturers of Pressed and Blown Glassware for the past seven years, has been named as an assistant to Mr. Lind.

According to Mr. Hall's statement, the aim of the new department is to "preserve the historical and traditional practices of multi-employer unit collective bargaining between the manufacturers of glass containers and tableware who are members, and the unions who are the collective bargaining agents for their employees."

NOMINATIONS FOR THE ALBERT VICTOR BLEININGER AWARD INVITED

Nominations for the Annual Albert Victor Bleininger Award for meritorious achievement in the ceramic industry are now open for 1955. This award is presented by the Pittsburgh Section of the American Ceramic Society.

The closing date for nominations is November 15 at which time the committee meets and makes the award to be presented to the candidate who has been selected at the March 11 meeting. Announcement of the recipient of the award is made at the December meeting.

Nominations are to be sent to the Chairman of the Bleininger Award Committee, Harold E. White, R. D. #6, Butler, Pa.

CORNING DEVELOPS AUTOMATIC GLASS CAPACITOR MACHINE

The successful development of an automatic machine to produce glass capacitors at rates up to 30 times faster than present manual methods has been announced by Corning Glass Works. This high-speed machine will permit economical manufacture of large quantities of high quality glass capacitors. As a result, American production of these essential electronic components formerly made of mica is now independent of foreign sources of raw material supply.

Automatic production will be initiated by Corning in the CY 10, CY 15, CY 20 and CY 30 sizes. Because of their relatively high capacitance to volume ratio, these units offer a higher degree of miniaturization than any other high quality capacitor on the market. For example, capacitances up to 1,200 mmfd can be obtained in CY 15 units, which are only 0.017 cubic inches in size.

THE COVER

The largest sheets of glass ever cast in this country have been installed as part of the exterior of the new Fifth Avenue office of the Manufacturers Trust Company, currently under construction at the corner of Fifth Avenue and 43rd Street in New York City. The five-storied, glass-walled building, an entirely new concept in bank design and construction, will be open to the public in the early fall.

Combining massive 1,500-pound sheets of glass, ½-inch thick, with polished aluminum, Skidmore, Owings & Merrill, architects, have created a structure containing an expanse of 13,000 square feet of glass. Because the second floor is set back mezzanine-fashion from the 43rd Street and Fifth Avenue walls, there is virtually an uninterrupted 32-foot stretch of glass from the ground to the third floor. The glass is set in aluminum and steel frames and will be washed on the outside from a scaffolding arrangement operated from built-in roof suspensions. Such an arrangement is required because, paradoxically, this is a "windowless" building. The glass is sealed in place to eliminate dust-laden air and to increase the air-conditioning and housekeeping efficiency.

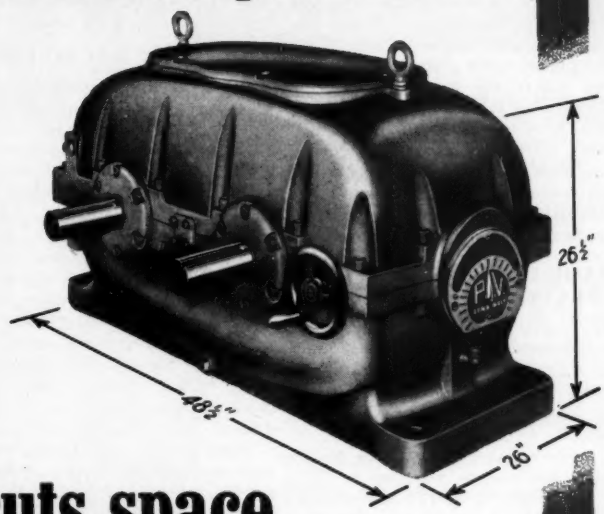
The glass, produced by Franklin Glass Company, was made by a method which requires casting the sheet at approximately ¾ of an inch thick. The rough glass is then embedded in plaster of paris, one side at a time, on a grinding table. The grinding wheels, using wet sand, smooth the sheet to the desired half-inch thickness. Then polishing wheels are used to complete the product.

Producing the glass was particularly challenging because the usual size of large glass sheets for building use is ¼-inch thick with over-all dimensions not exceeding 10 feet. As a precaution against accidents, extra sheets of the 22 footers have been produced as reserves.

On arrival at the building site on Fifth Avenue, the crates are raised by crane to a scaffolding. Here a crew of Abbott Glass Company specialists unload the glass and edge each sheet into position. A crew of men operating on four levels is needed to handle one sheet. As the glass is eased into the frame, it makes contact with a rubber-cork composition gasket which has already been fitted to the molding. A special glazing compound is then applied. The molding is so engineered as to accommodate the contraction and expansion which occurs with changing weather.

Spandrels at the third, fourth and fifth levels band the building between floors. These are constructed from wire-glass panels, the backs of which have been sprayed with a slate gray vinyl plastic to impart the exact color and sense of depth desired. The panels, 66 in all, are approximately 3½ by 9 feet.

LINK-BELT 25-hp P.I.V. Variable Speed Drive



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The Size 6 P.I.V. is built in three types: The basic drive . . . with input *or* output gears . . . with input *and* output gears. All are available in a wide range of ratios, 20 to 25 hp.

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P.I.V. LINK-BELT P.I.V. VARIABLE SPEED DRIVE

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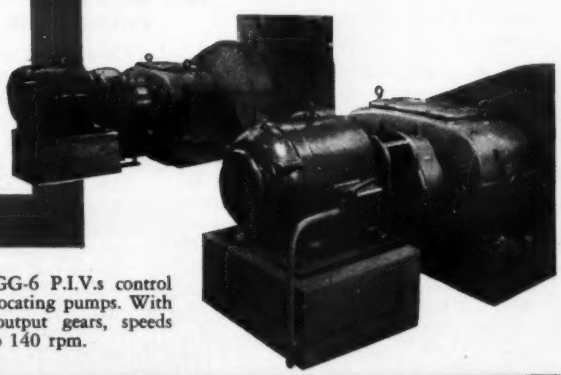

Two Link-Belt HGG-6 P.I.V.s control the speed of reciprocating pumps. With both input and output gears, speeds range from 46.5 to 140 rpm.

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HORIZONTAL OR VERTICAL MOUNTINGS
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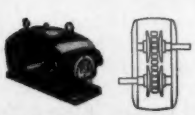
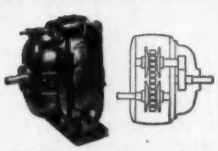
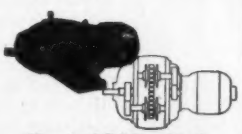


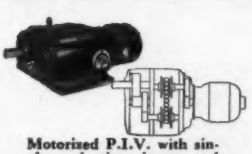
Basic, Positive, Infinitely Variable (P.I.V.) Speed Drive.



P.I.V. with single reduction input or output helical gears.

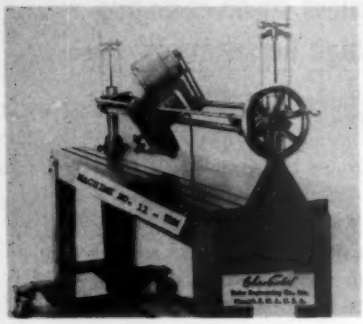


Motorized P.I.V. with single reduction input and output helical gears.



Motorized P.I.V. with single reduction input and double reduction output helical gears.

New Equipment and Supplies



ABRASIVE CUTTER

Eisler Engineering Co., Inc., 750 South 13th Street, Newark 3, New Jersey, has announced development of its #11-TMM abrasive cutter of the wet type for cutting and slicing tungsten, molybdenum and other non-ferrous as well as refractory materials and glass, particularly in thin sheets.

The machine is well suited to make accurate longitudinal cuts on bars, tubes and sheets. The work head carries cutting wheel 12″ diameter x 1/16″ thick operating at 1,720 RPM from motor of ¼ HP. The work head slides on two bars of 1¼″ diameter and cranked over an effective distance of 42″. The travel is manual by means of a hand wheel and feed screw which engages a half nut on the work head. For quick return, the half nut is disengaged from the feed screw, and the work head is then easily moved back by means of a handle. The work head can be tilted and locked at any angle from vertical to horizontal and a protractor indicates the angle.

NEW ULTRASONIC GAGE USES TV SCREEN

Branson Instruments, Inc., Stamford, Conn., has announced the featuring of a 21″ television tube in its new "Vidigage", an automatic ultrasonic gage for measuring thickness of glass, metals, rigid metals, etc. Thickness is indicated clearly on the large size screen which allows for scales 17″ long.

A sweep-width adjustment permits an almost infinite choice of thickness scales making it possible to read directly thicknesses from 0.012″ to 2.5″, with accuracies as high as 0.1%. Beyond 2.5″, thicknesses up to 10″ can be readily calculated. Circuits have been improved so that the thickness indication on the screen is a single sharp line.

ELECTRIC OVEN

Steiner-Ives Company, 333 Springfield Avenue, Union, New Jersey, is offering its University electric oven suitable for annealing, heat treating, brazing, curing, etc.

Thorough and economical heating is accomplished in this oven which operates by the principle of moving a large volume of heated air at high velocities about the work being treated. A 10″ stainless steel recirculating fan located in the roof of the oven blows the air down past the heaters which are located in the side walls of the oven behind suitable baffle plates. The heated air then enters the work chamber of the oven, rises vertically across the work and is returned to the circulating fan. This method of forced air recirculation eliminates air stagnation and with pyrometer-type instruments for automatic temperature control assures uniform heating throughout the oven.

STORAGE RACK FOR PLATE GLASS

Glass Center Enterprises, Inc., 128 Summit Street, Toledo, Ohio, has developed a newly designed and prefabricated slot rack for the storage and merchandising of plate glass and mirror stock.

The rack, which is 48 inches wide and will accommodate glass up to 120 inches in height and 144 inches in length normally, is equipped with six separate sections for storing the full range of usual bracket sizes.

Each lite of glass slides into a slot in the maple flooring and at the top is held between thin hardboard separators smooth on both sides. The separators are so designed that they may be placed on the yoke individually and an extended steel leg supports each group of separators and the glass against any vertical movement.

WET DUST COLLECTOR

Pangborn Corporation, Hagerstown, Maryland, has announced the development of its Type "CW-1" centrifugal wet dust collector for those dust control problems which cannot be solved by the use of cloth type collectors.

The Type "CW-1" collector is of counter-current design (air flow counter current to water flow) and of tower type construction. It consists of multiple wet vane sections and a final water entrainment vane section. The diameter of the collector varies in proportion to the air volume handled and the number of wet vane sections is governed by application requirements.

The water supply enters above the top wet vane section and flows downward or counter to the upward flowing air, which enters the collector through the lower tangential inlet. The patented vane design provides greatly increased impingement surface and imparts vigorous, centrifugal action to both the air and water to produce thorough intermixing. Increased capacity is obtained in reduced space and channeling is prevented. Water and dust are discharged as sludge from the lower cone and the clean air from the air outlet at the top. After clarification in settling tanks, the water may be recirculated since no spray nozzles are used, the water inlet being an open end pipe.

CATALOGS RECEIVED

Minnesota Mining and Manufacturing Company, 900 Farquier Street, St. Paul 6, Minn., has made available a new booklet, "Grinding and Polishing Glass with the 3M Method".

The publication points out that glass grinding and polishing with coated abrasive belts improves finishes on glass edgework, reduces operator fatigue, cuts labor and unit costs, and increases production up to one-third. The illustrated booklet makes specific recommendations for rough grinding, polishing, semi-luster finishing and clear luster finishing of mirror and table top glass, and similar recommendations for finishing automobile glass. A chart depicts test results comparing four methods of glass grinding, based on the average amount of cut in 15 seconds.

Also described are three types of "Wet-or-Dry" coated abrasive belts and applications for a portable belt sander, such as "on-the-job" seaming and mitering edges of window glass, store front glass and other heavy-duty glass sections.

Acheson Colloids Company, Division of Acheson Industries, Inc., Port Huron, Michigan, has published Bulletin No. 460 featuring 'dag' colloidal dispersions.

The history of colloidal graphite is discussed in the new catalog. A centerfold table lists 40 basic dispersions of graphite, molybdenum disulfide, vermiculite and zinc oxide, in carriers such as water, oil, volatile hydrocarbons, resin solutions, alcohol, glycol and wax emulsions. Comparative particle size and consistency of each dispersion are given, as well as dilution information and typical applications.

Reynolds Chemicals, 2500 South Third Street, Louisville, Kentucky, has issued a new brochure describing the various Reynolds Aluminum chemicals now available.

The brochure describes alumina trihydrate available from the firm. It also describes Reynolds activated alumina, which is purified alumina trihydrate with about two-thirds of the chemically combined water eliminated, and calcined alumina, which is prepared from alumina trihydrate by heating at a temperature around 1100°C. Also covered in the brochure is Reynolds-produced dross, bauxite and aluminum powders.

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THE QUEEN'S "BIRTHDAY LIST": DR. HAMPTON HONORED

Word was recently received from England that the Queen, in her "Birthday Honors List", included the name of a celebrated British Glass Technologist, Dr. W. M. Hampton, who has frequently visited the United States and is well known to American glassmen. In World War I, Dr. Hampton joined the Research Department of Messrs. Chance Brothers and Company, the "Corning Glass Works of England", to help in the improvement of optical glass manufacture, and not long afterward succeeded Professor Lamplough as Head of the Research Department. As the years went by, his interest in glass generally broadened and he took over managerial functions in the Lighthouse Department and other branches, until comparatively recently he was made President (to use the American term*) of the company.

For many years past, he has been active in the British Society of Glass Technology, and is well known for his activities in determining the behavior of furnaces and devising merit-ratings for them, and for numerous publications on the design of lighthouse lenses, the manufacture and properties of optical glasses and many matters of general interest. He has also concerned himself with the business aspects of the Society, of which he was for two years President (1948-50). He was also active in the International Commission on Glass, having been until very recently its Treasurer and being still one of the official British Delegates.

Dr. Hampton received his basic education at the Wyggeston Grammar School for Boys, which might be regarded as equivalent in some ways to an American "Prep" School, and there he passed the entrance examination to Oxford University with high honors. However, he elected to go directly into industry, leaving academic matters for evening work. He studied chemistry and other subjects at the Leicester Technical College, and obtained his B.Sc. in chemistry at London University as an "external" student in 1916. Ten years later the same university awarded him a Ph.D. in the same subject.

In World War II, after the fall of France to the Germans, he undertook a hazardous and very slow journey across the Atlantic to establish an optical glass industry at Toronto in Canada and then, returning to England by way of Portugal, he trained Canadian technologists in the operation of such a plant. His methods were probably at the time as advanced as any in the world, though Dr. DeVoe at Corning Glass Works has since developed a continuous method of making optical glass which renders all older methods, if not obsolete, at least noncompetitive.

More recently, at the request of the Government of India, Dr. Hampton went to that country to help establish the manufacture of optical glass in the neighborhood of Calcutta. He is well known among, and a frequent visitor to, the glass factories of continental Europe.

He has a wife and two grown daughters, both of them physcians and surgeons in their own right. Since both his sons-in-law are also physicians and surgeons, it is to be presumed that medically he will be well looked after, and may live to an enormous age, notwithstanding the occupational hazards of broken glass, fiery furnaces and poisonous batch materials.

His recent honor is civic rather than academic, the title of "O.B.E." (Officer of the British Empire), a distinction originating with Lloyd George in World War I, being awarded to citizens whose service in any field is outstanding enough to attract the attention of the political authorities. There is no question that Dr. Hampton's almost single-handed cultivation and operation of the optical glass industry in Great Britain resulted in so smooth a functioning of it in World War II that there was grave danger of the political authorities never being aware of its existence and never realizing what part it played in the War.

We trust that Dr. Hampton will live long to enjoy the recognition that has come to him.

BALL BROTHERS NAMES EXECUTIVE OFFICER

Edmund F. Ball, President of Ball Brothers Company, Inc., has announced the appointment of W. C. Schade, formerly of Olin Industries, Inc., as Executive Vice Presiden and General Manager of Ball operations, to fill the vacancy that arose recently with the resignation of Duncan C. Menzies.

The appointment, Mr. Ball said, was effective immediately and placed Mr. Schade in charge of all manufacturing and sales activities for both the parent company and Ball subsidiaries.

Mr. Schade was General Manager of the Olin Arms and Ammunition Division, which operates the Winchester Repeating Arms plant at New Haven and the Western Cartridge plant at East Alton, Illinois. Associated with Olin Industries since 1941 in various production and sales capacities, Mr. Schade had previously been with the Koppers Company, the Brooks Paper Company and with a St. Louis firm of certified public accountants. He studied engineering at Cornell University and at Carnegie Institute of Technology, receiving a law degree from Washington University.

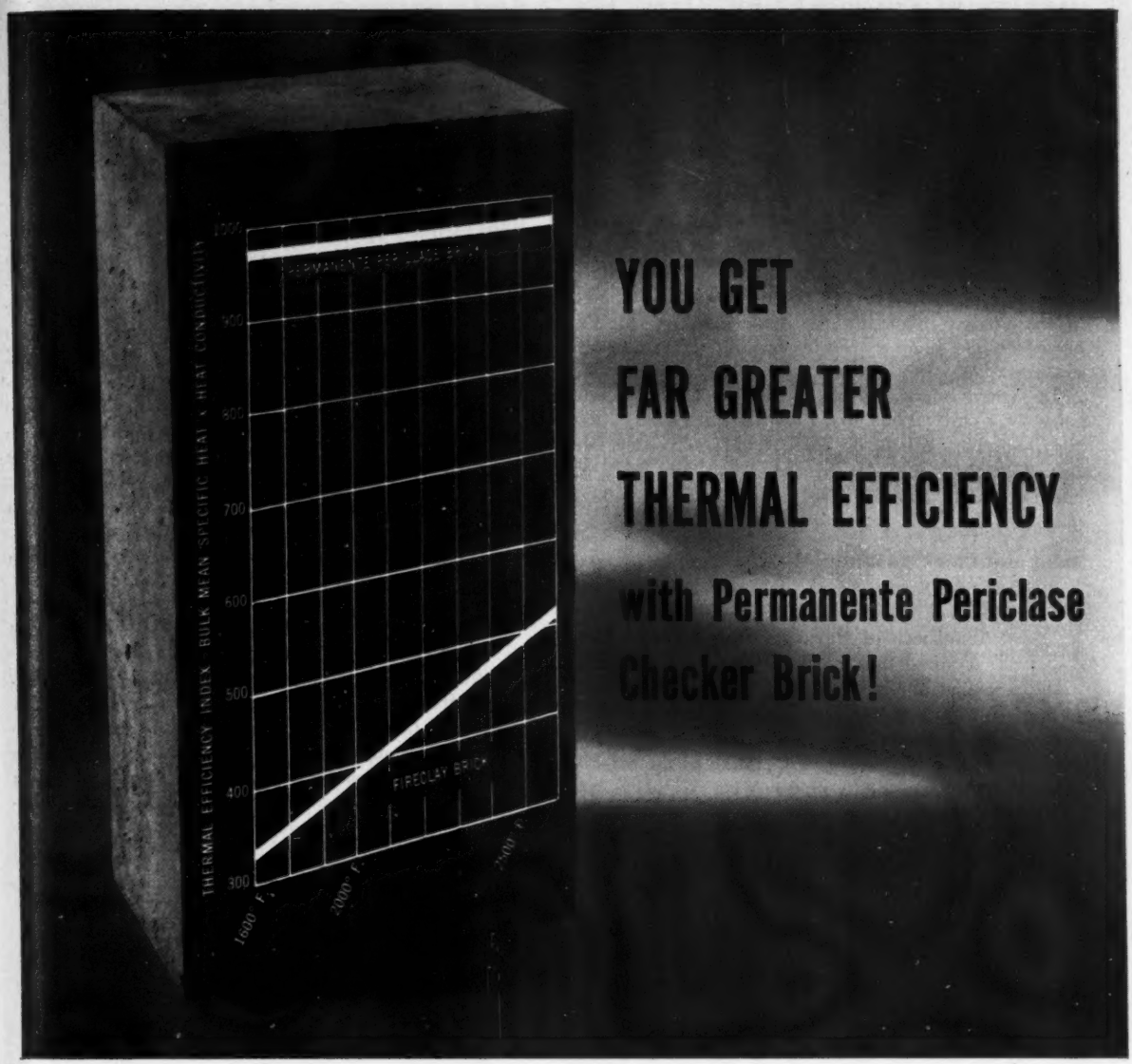
THATCHER NAMES GENERAL TRAFFIC MANAGER

Thatcher Glass Manufacturing Company, Inc., has announced the appointment of Walter F. McCreight as General Traffic Manager. Mr. McCreight will succeed Charles Latshaw who recently resigned.

Mr. McCreight, formerly assistant General Traffic Manager, has been with Thatcher for the past eight years. He has represented the company on the Dairy Industries Suppliers Association traffic committee since 1950. Prior to his joining Thatcher's Traffic Department, Mr. McCreight was with the Lackawanna Railroad.

Peter H. Theopheles has been appointed assistant General Traffic Manager to succeed Mr. McCreight. Prior to his new appointment, Mr. Theopheles was supervisor of Motor Transportation.

* The British term is "Managing Director".



YOU GET FAR GREATER THERMAL EFFICIENCY with Permanente Periclase Checker Brick!

THE CHART of theoretical ratings above shows the superior thermal efficiency you get when you specify Permanente *Periclase* "A" and "D" Brick for glass furnace checkers instead of fireclay brick.

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 440)

tion of a typical mold frame 20 with respect to the heating members 24 is also indicated. Utilization of the longitudinally extended heating tubes of this invention allows for considerable flexibility in the formation of the desired curves or bends. Relatively sharp bends adjacent the ends of the glass sheet may be successfully accomplished by two substantially parallel rows of burners or tubes. Should it be desired to effect a relatively sharp bend or curve along only one marginal edge, that area may be additionally heated by one row of the present tubes and the other marginal edge not heated to the same extent by turning off that row of heating tubes.

The patent contains 9 claims and the following references were cited: 1,566,563, Ross, Dec. 22, 1925; 1,791,404, Fahrenwald, Feb. 3, 1931; 2,111,392, Galey, Mar. 15, 1938; 2,176,999, Miller, Oct. 24, 1939; 2,213,406, Paddock et al., Sept. 3, 1940; and 2,561,529, Mongan et al., July 24. 1951.

Tube and Cane Machines

Apparatus for Sealing Mounts to Tubular Bulbs. Patent No. 2,671,986. Filed February 27, 1952. Issued March 16, 1954. Two sheets of drawings, none reproduced. Assigned to Westinghouse Electric Corp. by C. Wiener.

The principal object of this invention is to provide a machine to form a shoulder on a tubular bulb and simultaneously seal a mount as an improvement over the previous multiple-step method. The operation of the machine is as follows:

Discharge lamps are manufactured by cutting tubing to the desired length, mounting a length of tubing in a rotatable chuck and at the same time holding a mount with a flare on a pin rotatable at the same speed as the chuck. Needle-point fires are directed at the bottom edge of bulb while a spring-loaded roller resting on the edge of the tubing at the desired height contracts the tubing to meet the edge of the mount flare and thus effects fusion and complete sealing. The underside of the flare becomes soft and sags until it reaches the mount pin, giving uniform roundness to the bottom of the seal and simulating a conventional pull-down.

The patent contains 7 claims and the following references were cited: 1,906,315, Davis et al., May 2, 1933; 2,203,917, Malloy, June 11, 1940; 2,525,043, Nelson et al., Oct. 10, 1950; 570,920, Great Britain, July 27, 1945; and 641,235, Great Britain, Aug. 9, 1950.

Miscellaneous Processes

Sealed Glass Container. Fig. 5. Patent No. 2,670,868. Filed March 26, 1951. Issued March 2, 1954. One sheet of drawings. Assigned to Anchor Hocking Glass Corporation by H. E. Stover and G. M. Stuntz.

The present invention relates to an improved glass container and the package formed thereby. Various foods and other products are packed in glass containers and sealed with closure caps. Most of such products require a hermetic seal, and many require a partial vacuum within the package. This invention aims to provide an improved package and improved component parts which may be effectively sealed by high-speed machinery with a minimum of imperfect seals.

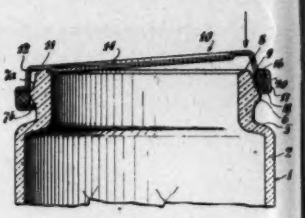


Fig. 5

The gently curved upper surface 7a, Fig. 5, facilitates application of a closure cap to the container and allows the closure to ride lower on the container when a preliminary seal is formed. The lower, more abrupt surface 7b securely holds the closure on the container. In addition, the rounded undersurface causes a cap removing tool or other instrument inserted under the bottom of the closure to slide along without chipping or breaking the glass. This latter feature is important in order to avoid breakage and to guard against chipped glass setting into a packaged product. The closure comprises a cover portion 11 and a depending skirt 12. The cover portion has a depressed panel 14 which is sufficiently large to receive the reduced lower end 4 of the container whereby the sealed packages may be readily stacked without fear of their "creeping" sidewise when subjected to vibrations and shock and toppling off.

The patent contains 1 claim and 15 references were cited.

Glass Electrode. Patent No. 2,668,143. Filed January 19, 1950. Issued February 2, 1954. No sheets of drawings. Assigned to Beckman Instruments, Inc. by Paul T. Gilbert, Jr. and Edwin P. Arthur.

The invention relates to glass electrode for pH measurement and more particularly to glass electrodes having pH-sensitive membranes of lithia glass. As disclosed in the patent to Cary et al., No. 2,462,843, lithia glass electrodes have outstanding advantages over the previously-used electrodes having membranes of sodium glass, such as Corning 015.

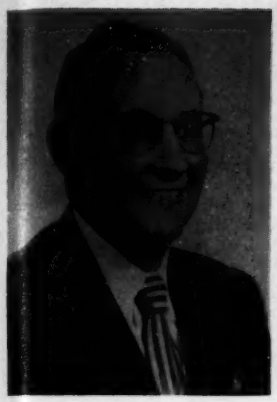
A preferred glass suitable for electrodes had the following composition in proportions by weight:

Li_2CO_3	about	181	parts
$BaCO_3$	"	138	"
La_2O_3	"	81	"
CeO_2	"	77	"
SiO_2	"	369	"

In heating, a portion of the ceric oxide dissolves with ease but only by long-continued heating at temperatures near 2500°F. can the remaining portion be dissolved. It is recommended that the glasses be fused in platinum.

Such glasses possess unexpected chemical durability in certain hot corrosive media, as evidenced by unexpected constancy and uniformity of response to variations in pH, as compared with a corresponding glass in which the mixture of La and Ce is replaced by an equivalent content of La. Such glasses are also superior to the corresponding glasses containing Ce alone as the rare earth component, not only in possessing lower sodium ion errors but in being far easier to fabricate. Another advantage of the glasses is that a fresh or new electrode made therefrom can be put into use without preliminary treatment.

The patent contains seven claims and the following references were cited: 2,444,845, Perley, July 6, 1948; 2,462,843, Carey et al., Mar. 1, 1949; and 2,497,235, Perley, Feb. 14, 1950.



J. Minshall

R. T. Drennan

KAISER SALES APPOINTMENTS

Russell T. Drennan has been named General Sales Manager of the Kaiser Chemicals Division, according to an announcement by F. M. Cashin, Chemicals Division Manager of Kaiser Aluminum & Chemical Corporation. He will be headquartered in Oakland, California. At the same time, John Minshall has been assigned as Eastern Regional Sales Manager for the Chemical Division in Akron, Ohio. He was formerly a product specialist there.

Joining Kaiser Chemicals in 1946, Mr. Drennan was appointed chief chemist of the company's Baton Rouge, Louisiana, alumina plant. He subsequently became a product specialist, later Regional Sales Manager and then Eastern General Sales Manager in Akron. Mr. Drennan's new duties will include supervision of Kaiser Chemicals' regional offices in Akron, Chicago and Oakland, and their subsidiary district offices, for sales of alumina, magnesia, magnesite, periclase, dolomite, basic refractories and raming materials.

Mr. Minshall joined the Kaiser firm in 1941 in the then operating magnesium foundry. He later became senior sales engineer in Oakland before being transferred to Akron.

SILICATE RESEARCH INSTITUTE APPOINTMENT

Dr. Wingate Lambertson, Professor of Silicate Science at the University of Toledo, has been appointed administrative assistant to Dr. Wilhelm Eitel, Director of the Institute of Silicate Research. Dr. Lambertson will be in charge of contacting industries interested in supporting the Institute with a view to adding to available financial resources. He will also visit universities to interview students applying for fellowships at the Institute.

Three graduate fellows have already been appointed to the Institute and six more grants will be awarded within the next few months. Fellows will receive Master of Science degrees in silicate science when they complete the special 2-year training and directed research.

Takashi Fujii has received the first Toledo University silicate fellowship. He is a mineralogist and geologist, and a graduate of Tokyo University. He came to the U.S. as a Fulbright fellow and studied at Yale University last year. Heyman Duecker, a Purdue University graduate, will begin study September 1 as an Owens-Illinois Glass Company fellow in the Institute. Glen Calcmuggio, a graduate engineer, is now studying in the Institute.

OWENS-ILLINOIS TO BUILD SAND PLANT

Announcement has been made that Owens-Illinois Glass Company will build a sand plant at Ione, California, following the discovery and engineering effort that led to the development of a new and abundant glass sand deposit there.

Scheduled for completion the latter part of this year, the plant will produce one of the best grades of silica sand on the West Coast, according to H. S. Wade, General Manager of the company's Pacific Coast Division. The Ione sand deposit was discovered by O-I engineers who had gone to Jackson and Sonora to investigate the possibility of using silica sand that is part of the residue from gold mining.

Returning from this unsuccessful venture, the O-I engineers stopped at a clay pit operated at Ione by the Gladding-McBean Company. Struck by the brilliant whiteness of the deposits, the engineers investigated and learned that the deposits contained 40 per cent clay and 60 per cent of the purest kind of silica sand. Sand from a pilot operation then set up was used to produce glass containers at the Oakland plant and company officials rated the glass as among the clearest made at any of its 16 glass plants.

The new plant site is on a 33,000 acre estate, owned by C. S. Howard. The glass firm will construct five buildings, including processing mills, and office and storage space on the grounds, which it is sub-leasing from Gladding-McBean. At the start, the plant will employ about 20 people.

LYNCH NAMES THREE SALES OFFICIALS

Russel L. Sears, Vice President and General Sales Manager of Lynch Corporation, has announced the appointment of three sales officials. A. V. Petersen, former Sales Manager of Compressor Sales, was advanced to Sales Manager of Packaging Machine Sales upon the retirement of M. V. Girkins, who had been associated with the firm since 1936. Merle F. Stutzman was appointed Sales Manager of Compressor Sales, and R. N. Craven was named Manager of the Mid-western District Offices at Chicago, Illinois.

Mr. Petersen has been with Lynch's Compressor Sales since 1946, becoming Sales Manager of that division in 1951. He attended North Dakota State College and took graduate work at Chicago University. He served with the U.S. Navy, and shortly after his discharge, accepted a position with Lynch Corporation. He was District Manager of the Southern District Offices for four years before assuming duties as Sales Manager of Par Compressor Sales.

Prior to accepting a position with Lynch, Mr. Stutzman was Service Manager and General Manager of Refrigeration Supply Distributors of Los Angeles from 1930 to 1952, when he became Store Manager and Purchasing Agent of Thermal Products, Inc.

Mr. Craven has been assistant to the District Manager of the Eastern District Offices of New York City since 1952, prior to his recent appointment. He is a factory-trained sales and service engineer who is capable of extending a comprehensive service to the customers of Lynch Corporation.

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GALVANIC POTENTIALS . . .

(*Continued from page* 436)

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Overmyer Iron Clinic

The Overmyer Mould Company, Inc. has announced that its annual Iron Clinic will be held in Winchester, Indiana, on Thursday, September 16. Discussions on mold metallurgy, and the proper care, repair and cleaning of mold equipment have been scheduled.

A progress report will be given on the Colmonoy process and of special interest will be a discussion of a comparatively new process through which the surface of the mold coming in contact with glass is faced with a special type of chrome finish. Discussion will be held during the early part of the day, with evening hours set aside for social activities.

HOUZE ELECTS PRESIDENT

E. V. Ogg, Executive Vice President and General Manager of the L. J. Houze Glass Company, has been elected President. At the same time it was revealed that Thomas M. Evans had been elected to the Board of Directors replacing Mrs. Louise Houze Morris. Other Directors are Mr. Ogg and Charles W. Veatch, Vice President of the Mellon National Bank and Trust Company of Pittsburgh. Mr. Evans was elected Chairman of the Board.

Mr. Ogg replaces as President, Armand Houze Sr., son of the founder of the company, who is retiring to an advisory capacity. Mr. Ogg said that no other change of officers is contemplated.

PEMCO EXPANSION

Facilities for production of color at Pemco Corporation will be increased by approximately 200%, it was stated by Herbert Turk, Executive Vice President of the firm, when announcing the new color calcining furnace which went into operation about July 15.

"While our previous batch type operation was satisfactory—in conjunction with our program of quality control —we now will be able to give better service and continue our program of assuring uniform products on the ever-increasing number of large volume orders that are the result of recent developments in the field," Mr. Turk said. "While this new furnace will give Pemco much better control of uniformity, the resulting product will mean fewer control problems in customers' plants."

Installation of this furnace is another step in Pemco's expanding facilities in the field of colors, a program which began several years ago with the installation of scientific equipment for matching colors.

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CERAMIC RAW MATERIALS

GLASS INDUSTRY Potash and Soda Feldspars, High Alumina—all standard mesh sizes. Low Iron Silica Sand and Aplite.

POTTERY INDUSTRY Potash and Soda Feldspars for bodies and glazes—all standard mesh sizes. Potters Flint.

PORCELAIN ENAMEL INDUSTRY Potash and Soda Feldspars for all types of porcelain enamel—all standard mesh sizes. Ground Quartz.

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ANNEALING FLAT GLASS . . .

(*Continued from page* 429)

perature", and the lower temperature $T_1 = \theta_{tr}$–50°C., i.e., the two temperatures which limit the range of abrupt variation in equilibrium density. In the case of the glass of Fig. 4, these two temperatures would be respectively 590° and 500°C.

The confirmation of this can be judged from Fig. 15 which gives the complete curves of such a treatment applied to the glass studied in this work. The table in Fig. 4 gives the results of the structural stabilization which are far higher than those obtained by stabilizing during the same lapse of time at a uniform temperature. Fig. 16 shows the comparison between the behavior of the glass annealed according to our hypothesis and the glass annealed according to the standard procedure actually used by the producer of the glass studied.

In order to confirm this view, we subjected another glass to a similar annealing. Judging from Table I, this reasoning is likewise confirmed for the glass totally different from the first.

Conclusion

It appears, in the light of the facts mentioned above, that by traversing the natural cooling curve between T_s and T_1 it is possible to obtain a better result (for a given time) compared to the standard annealing, as much from the point of view of birefringence as from the point of view of structural stabilization of the glass.

Densities of Glass (continued)

Densities Used for the Establishment of Approximate Equilibrium Curves

10	188											
		Density (quenched)				Density (test)				Density (stab.)		
		2.4880	+	0.0012		2.4793	+	0.0006		2.4926	+	0.0007
			—	0.0011			—	0.0007			—	0.0006
	710°		650°		630°		620°		610°		600°	
	2.4793		2.4795		2.4797		2.4801		2.4807		2.4814	
Diff.		0.0002		0.0002		0.0004		0.0006		0.0007		

Density Θ_{tr} = 2.4863; % stabilization: 65.5%

10	173	A										
		Density (quenched)				Density (test)				Density (stab.)		
		2.5165	+	0.0007		2.5059	+	0.0005		2.5234	+	0.0001
			—	0.0004			—	0.0003			—	0.0003
	730°		650°		630°		620°		610°			
	2.5059		2.5059		2.5062		2.5071		2.5091			
Diff.		0.0000		0.0003		0.0009		0.0010				

Density Θ_{tr} = 2.5143; % stabilization: 60.5%

10	190											
		Density (quenched)				Density (test)				Density (stab.)		
		2.5153	+	0.0005		2.5052	+	0.0004		2.5213	+	0.0005
			—	0.0008			—	0.0010			—	0.0003
	710°		650°		630°		620°		610°		600°	590°
	2.5052		2.5055		2.5057		2.5059		2.5061		2.5066	2.5078
Diff.		0.0003		0.0002		0.0002		0.0002		0.0005		0.0012

Density Θ_{tr} = 2.5126; % stabilization: 62.6%

BATTELLE EXPANSION

Battelle Memorial Institute has just completed the purchase of a 397-acre plot of land fifteen miles west of downtown Columbia. According to Dr. Clyde Williams, President and Director of Battelle, the acreage is needed because of newly-developed opportunity for the Institute to engage in more large-scale experimental projects in engineering and agricultural fields.

Battelle has conducted an almost continuous expansion program since 1935. Indicative of the research center's growth is its increase in personnel. The present staff of 2150 is more than double that employed at the close of World War II. Its dollar volume of research was $13,500,000 in 1953.

FERRO ACQUIRES KILN COMPANY

Ferro Corporation has concluded the acquisition of the patent rights and related assets of the Peterson Kiln Company, Los Angeles, California.

The Allied Engineering Division of Ferro will take over the production of the light, portable continuous kiln in which the Peterson Kiln Company has been specializing.

GLASS COMMISSION . . .

(*Continued from page* 432)

It was therefore interesting to obtain an insight into both the processes in the "sulphur treatment" of glasses and the composition of glass surfaces in general. Etching of thin layers, each of a few hundred Angstroms in thickness, showed the influence of the "sulphur treatment" and gave explanations of the composition of glasses on and near the surface.

Networks in Glasses and Other Polymers. *By Dr. J. M. Stevels, Eindhoven, Holland.*

A number of the physical properties of glasses are directly related to the degree of interlinkage of their networks. This interlinkage is determined in the first place by the chemical composition of the glass, but also the previous history has its influence. Tools to study the degree of interlinkage are the measurements of the power factor at very low temperatures, the absorption in the ultraviolet part of the spectrum and the heat conductivity.

These methods have also been applied to silicones and pure organic polymers. Interesting conclusions can be drawn about the resemblances and the difference between glasses and other polymers.

A Theoretical Consideration of Some Properties of Glass in Transformation Range. *By Prof. T. Moriya, Tokyo, Japan.*

A discussion of the changes in the properties of glass with time in the transformation range is based on the hypothesis that the changes in the structure of glass tend towards an equilibrium state. The structure of glass is considered to be a grouped structure of glassy micro-elements, the sizes of the elements being assumed to change with temperature. The dependence of the volume of the elements in equilibrium on the temperature and the dependence of the volume of the elements at constant temperature on time are derived theoretically.

The properties of glass, such as viscosity, delayed elastic effects, strain release and change of the refractive index with time in the annealing range, are shown to depend upon the volume of the elements existing in the glass. The equations representing the dependence of the viscosity on the temperature and the change of viscosity with time in the transformation range are introduced by considering the change of the volume of the elements. The thermal strain release and the change of the refractive index are explained by the expressions deduced from the theoretical considerations of the change of the volume of the elements with time.

NEW GLASS-SEAL THERMOPANE UNIT

A new glass-to-glass sealed insulating window unit has been announced by E. M. Everhard, Vice President in charge of Sales of Libbey-Owens-Ford Glass Company.

The new glass-seal Thermopane unit will be made for the present in two wood sash sizes—45½" by 25½" and 42½" by 22½"—and two metal sash sizes—36" by 24" and 34 11/16" by 22 11/16". These sizes have been popular in the large volume panel window market.

The glass-seal Thermopane units will be made with two lights of double-strength "A" quality sheet glass with a quarter-inch dehydrated insulating air space between the two lights of glass. They are packed 25 to the case for shipment. The units will have an over-all thickness of a half-inch and will be easy to glaze and handle on construction jobs.

• American Potash & Chemical Corporation has adopted the trade name V-Bor for its refined pentahydrate borax used in glass, ceramics, porcelain and other manufacturing processes.

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RESEARCH DIGEST . . .
(*Continued from page* 442)

conditions and required a net pressing force of 3150 lb. A similar article pressed with glass 130° colder required a pressing force of 17,000 lb. or four times as much. The respective viscosities were 1600 poises and 5500 poises, i.e., 3.4 times as stiff. Thus one might be forced into working on a most undesirable part of the curve. If this does happen, then measures should be taken to get over the difficulty.

For deep pressings, the toggle mechanism is not altogether suitable. In this case a steady pressure is required over a much greater distance of plunger movement. The pressure characteristic of the toggle press shows that this cannot be achieved, so direct pressing is employed with much higher compressed air pressures; e.g., 80 lb./sq. in. giving a 9000-lb. plunger pressure. On a toggle press, this would be obtained by using a mechanical advantage of 2.65 with an air pressure of only 30 lb./sq. in., the toggle spread being quite low, namely, 19⅞ inches. This modification would correspond to the cam lock on the offset press for deep pressings.

The hand presser is fully aware of the points just outlined. They do try to get their glass as hot as possible for the job in hand and place it correctly in the mold. The mold is then brought under the plunger as quickly as ever possible and pressed immediately. They know that failure to do this means harder work for them, and lower production. These points are not always so easy to appreciate in operating automatic presses.

NEW CARBORUNDUM VICE PRESIDENT

Semon H. Stupakoff formerly President of Stupakoff Ceramic and Manufacturing Company, was elected Vice President of the Carborundum Company, according to an announcement by General Clinton F. Robinson, Carborundum President.

The Stupakoff Ceramic & Manufacturing Company was acquired by Carborundum in early 1954 and was recently made a division. As a Vice President of The Carborundum Company, Mr. Stupakoff will continue to direct the activities of the Division.

Mr. Stupaffok, son of the founder of the Stupakoff company, started in the laboratories of his father's establishment at Pittsburgh in 1916 on a part-time basis while attending Carnegie Institute of Technology. Practically his entire business career has been spent in the company, becoming its Treasurer in 1925 and President in 1928.

PEMCO ADDS TO RESEARCH STAFF

Edwin E. Childs, Jr. has joined the Research Department of Pemco Corporation in the capacity of senior research engineer, according to an anouncement by Herbert Turk, Executive Vice President.

Mr. Childs graduated from Virginia Polytechnic Institute with a Bachelor of Science degree in Ceramic Engineering. He received his Master of Science degree from Ohio State University. Mr. Childs' assignment, for the present, is to assist in the development of new and improved inorganic colors and glass frits.

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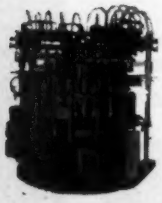

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BROCKWAY ELECTS VICE PRESIDENT

Brockway Glass Company has announced election of R. L. Warren, Jr. to the office of Vice President.

A graduate of Lafayette College with an M.B.A. degree from Harvard Graduate School of Business Administration, Mr. Warren has been with the company for nine years and has served during the past several years as Assistant Secretary and Assistant Treasurer. He has been a member of the Board of Directors since November 1953.

As Vice President, Mr. Warren will be in charge of a new division within the company organization consisting of the Quality Control, Traffic, Art and Design, Scheduling and Specifications Departments.

• George D. Kelly, ceramic engineer, has joined the staff of Battelle Memorial Institute, according to a recent announcement. In his new position at the research center, Mr. Kelly will specialize in problems involving glass. He has been engaged in development work on glass-to-glass and glass-to-metal seals at Sylvania Electric Products Corporation.

CONSOLIDATED FELDSPAR STAFF CHANGES

Announcement has been made by the Consolidated Feldspar Department of International Minerals & Chemical Corporation that G. G. Hanson, Western Representative, has retired July 1 after some thirty years of service to the ceramic industry.

Kenneth H. Hansen, formerly with Loomis Talk Company, will succeed Mr. Hanson. Mr. Hansen will make his headquarters in Columbia, Missouri.

FOXBORO NAMES NEW TRAINING SCHOOL DIRECTOR

W. H. T. Furry has been named Director of the Training and Educational Division of The Foxboro Company, succeeding Malcolm B. Hall who recently completed 40 years of service with the firm.

Widely experienced in instrument education work, Mr. Furry has taught courses for Pennsylvania State College in cooperation with the Philadelphia Section of the Instrument Society of America and also served as Chairman of the Educational Committee of the Philadelphia Section of ISA. Prior to joining Foxboro in 1952, he was Instrument Trading Coordinator at the Atlantic Refining Company.

REFRACTORIES INSTITUTE OFFICERS

F. H. Atwood, Vice President of Harbison-Walker Refractories Company, was re-elected President of The Refractories Institute at the annual meeting last week.

F. H. Laube, Jr., Executive Vice President of Freeport Brick Company, was elected Treasurer.

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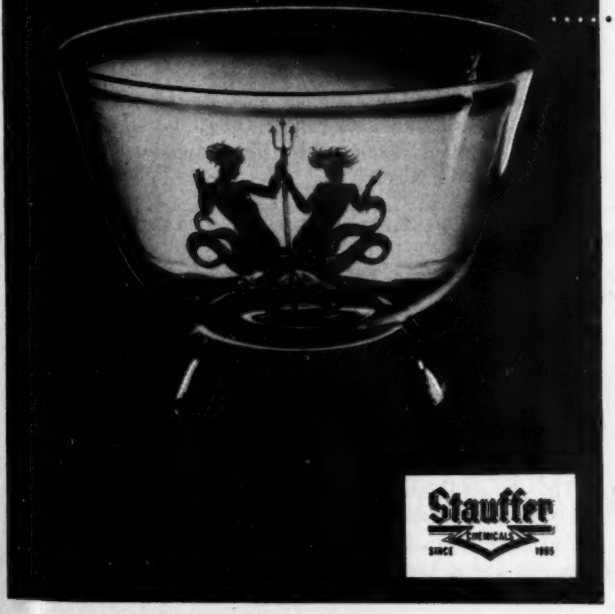

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THATCHER OFFERS LIFETIME GUARANTEE ON GLASBAKE LINE

McKee Division of Thatcher Glass Manufacturing Company, Inc., has announced that for the first time in consumer glass cookingware history, a lifetime guarantee is being offered with all of their Glasbake items. The purpose behind this move is to promote confidence with potential customers who now fear breakage of glass cookingware from oven heat.

The new Thatcher Guarantee covers all Glasbake items in their McKee Division line, including coffee bottles, french casseroles, basketware and the silhouette in the Glasbake line.

NEW OFFICERS OF A.S.T.M.

At the recent 57th Annual Meeting held by the American Society for Testing Materials, the following officers were elected for the current term.

The new president of the Society is Norman L. Mochel, Manager of Metallurgical Engineering at Westinghouse Electric Corporation; Vice President, Rudolph A. Schatzel, Vice President and Director of Engineering of Rome Cable Corporation; new members of the Board of Directors, Edward J. Albert, President and Treasurer of Thwing-Albert Instrument Company, John M. Campbell, Administrative Director at General Motors Corporation, Paul V. Garin, Engineer of Tests at Southern Pacific Company, John H. Jenkins, Chief of Forest Products Laboratories of Canada, and Douglas E. Parsons, Chief of the Building Technology Division of the National Bureau of Standards.

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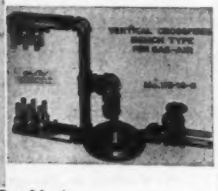

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DR. E. MARBAKER DIES

Dr. Edward Ellsworth Marbaker, 65, nationally known O. Hommel Company research chemist at Mellon Institute, died on June 2. He was nationally known for his achievements in ceramics, chemistry and metallurgy.

During the last 14 years, Dr. Marbaker devoted his efforts mainly to research in porcelain enamels. At the time of his death, he was a fellow on the Multiple Fellowship on Ceramic Chemicals sustained at Mellon Institute by The O. Hommel Company.

Born in Trenton, New Jersey, Dr. Marbaker became interested in rare metals while with Westinghouse Lamp Company, which he joined in 1910. He was chief chemist for the company from 1914 to 1917, when he left to join Alexander Brothers, where he remained until 1920. He later served General Electric Company, joining Mellon Institute as an industrial fellow in 1921. He was associated with the War Production Board and was Editor of *Mellon Institute News*. He edited the *Journal of the American Ceramic Society* in 1948 and 1949.

He leaves his widow, Mrs. Mable Price; a son, William E. of St. Louis; a daughter, Mrs. Wallis Boileau, III; and four grandchildren.

BAUSCH & LOMB EXPORT MANAGER RETIRES

Announcement has been made of the retirement of Gustave J. Husson, Bausch & Lomb Optical Company Export Sales Manager, following 43 years of service with the firm.

An expert linguist, Mr. Husson was born in Alsace-Lorraine, attended college in Switzerland and France, and traveled extensively throughout Europe before joining Bausch & Lomb as a bookkeeper in 1911. He became Manager of the Export Division in 1926.

STAUFFER CHEMICAL APPOINTS SALES MANAGER

Harold J. Klee has been appointed Manager of the newly organized Central Sales Division of Stauffer Chemical Company, it has been announced by T. A. Haschke, Director of Sales, Industrial Chemicals Division.

The Stauffer Central Sales Division has district sales offices in Chicago and Houston. Mr. Klee was formerly Manager of the Chicago sales district and will continue to make his headquarters in Chicago. J. H. Begley, formerly Assistant Manager, has been appointed Manager to succeed Mr. Klee.

FISHER ADDS TO STAFF

Dr. George L. Buc has joined the Central Control staff of Fisher Scientific Company as Technical Assistant to President Aiken W. Fisher. He will be a member of the new products committee and the development projects committee.

Since 1946, Dr. Buc has been Editor of the journal, *Applied Spectroscopy*, which he will continue to edit. He has also done basic research in the Calco laboratories of American Cyanamid for 12 years prior to his post at Tidewater Oil, from which he joined Fisher. He has set up pioneer installations of spectroscopic instruments at American Cyanamid, and holds 16 patents. He has also taught radio, mathematics and physics at Rutgers University.

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WESTVACO TO BUILD ANHYDROUS AMMONIA PLANT

Westvaco Chlor-Alkali Division, Food Machinery & Chemical Corporation, has been authorized to build an anhydrous ammonia unit at its South Charleston, West Virginia, plant.

A Certificate of Necessity has been issued providing for accelerated depreciation of 45% of cost. The new plant, with a capacity of 60 tons per day, will use by-product hydrogen from Westvaco's electrolytic chlorine-caustic soda operations. Completion is scheduled for the third quarter of 1953.

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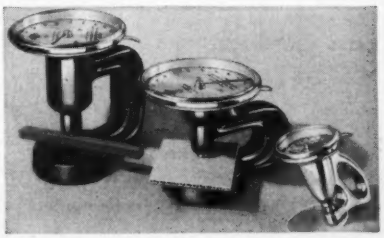

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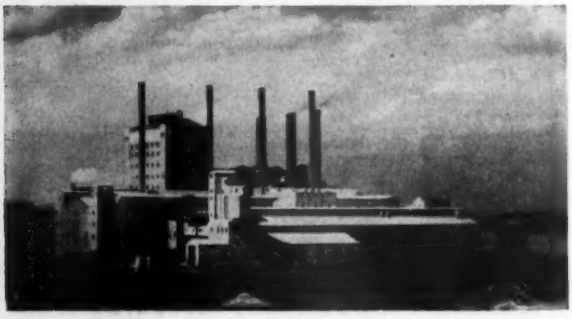
Milestones in Glass Progress

PHOTO COURTESY CORNING MUSEUM OF GLASS

1746 Here is one of the few known examples of glass decorated by Franz Greenwood, English master of stipple engraving. It stands almost ten inches high, and is crafted in a brilliant diamond-point engraving technique developed by Greenwood. The design is so delicately done that it seems to be breathed onto the glass.



1890 Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation, was founded by Captain J. B. Ford to supply Soda Ash to the glass industry; part of Wyandotte's modern Soda Ash facilities is shown above. Wyandotte has literally grown up with glass. Today, as in the past, it is a working partner, supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

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